Topics on the History of Tibetan Astronomy With a Focus on Background Knowledge of Eclipse Calculations in the 18th Century

Topics on the History of Tibetan Astronomy with a Focus on Background Knowledge of Eclipse Calculations in the 18th Century

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ABSTRACT

The eclipse calculations in Tibet feature religious implications. One religious issue is Buddhist chronology (*bstan rtsis*). With *Kālacakra* calculational bases, Tibetan *Kālacakra* astronomers have tried to synchronize with the Buddhist texts, stating that the Buddha's enlightenment occurred during a lunar eclipse of the full moon. The concept is called "backward calculation" (*yar log gi rtsis*).

Another religious issue is the rite of *poṣadha* (*gso sbyong*). At some point in Tibet, the idea of *ūnarātra* (*zhag mi thub*) in the *Abhidharma* literature was used to argue the accuracy of the weekday (*gza'*) value of the *skar rtsis* for the performance of *gso sbyong*. However, the decision of the accurate day for the *gso sbyong* during the 18th century Amdo became an issue. At stake was the conjunction with the occurrence of the solar eclipses, whose dates occasionally matched up with the Qing Chinese calendar, not with the *skar rtsis* calendar. Upon these cases, one of the possible solutions was to perform *gso sbyong* in conformity with region (*yul bstun gso sbyong*) according to the Chinese date.

Under the situation that an eclipse is closely tied to the religious chronology and practice, Tibetan astronomers made great efforts to produce the eclipse calculation results which were in accordance with direct experience (*mngon sum*). However, they have been confronted with the incongruity between their calculations and the real phenomena of an eclipse. Inevitably, the non-*Kālacakra* methods and knowledge, including observation, empirical data, debates, criticism, research into other traditions, etc. have been incorporated into the *skar rtsis* system based upon the *Kālacakra*.

Technically, adding a correction (*nur ster*), the correction of residual (*rtsis 'phro*), the correction of a Great Conjunction at the zero point (*stong chen 'das lo*), etc., within the conceptual and methodological framework of the *Kālacakra*, have been used to tally calculations with the real phenomena of an eclipse. Also, the non-*Kālacakra* Chinese *Lixiang kaocheng* system (later known as *Mā yang rgya rtsis*), which was based upon modern geometric and trigonometric knowledge, was used.

TABLE OF CONTENTS

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INTRODUCTION

CLASSIFICATION OF TIBETAN ASTRONOMY

Roughly two different lineages of *rtsis* (astronomy/ astrology) have been developed in Tibet: *skar rtsis, dbyangs 'char* (S. *svarodaya*) of Indic origin and *rgya rtsis* (*nag rtsis*, *'byung rtsis*), *Mā yang rgya rtsis* of Chinese origin.[1]

First, *skar rtsis*. Esoteric Buddhist *Kālacakra* texts such as *Laghukālacakra*, *Vimalaprabhā*, *Kālacakrāvatāra*, *Kālacakragaṇanopadeśa*, etc. play a significant role in the development of astronomy in Tibet. However, not much is known to us about the early

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[1] There is no clear-cut division between astronomy and astrology in Tibet such as in other ancient civilizations. Nevertheless, the following rough division may be possible:

	Indic Origin	Chinese Origin
astronomy	*skar rtsis*	*Mā yang rgya rtsis*
astrology	*dbyangs 'char*	*rgya rtsis* (*nag rtsis*, *'byung rtsis*)

In the case of *skar rtsis*, see Schuh's analysis and hypothesis for the terms, *skar rtsis, dkar rtsis*, and *dus 'khor rtsis* (See Schuh, 1973a: 13-9). In conjunction with it, the term *dus 'khor skar rtsis* is seen in the works of Kaḥ thog Rig 'dzin Tshe dbang nor bu (1698–1755) and Sum pa Mkhan po Ye shes dpal 'byor (1704–1788). — *odun-u ǰiruqai*, the Mongolian rendering for *skar rtsis*, simply shows that Mongolians take the "*skar*" in "*skar rtsis*" as *skar ma* (M. *odun*). — *Dbyangs 'char* is an astrological system that relates different vowels of Sanskrit alphabet to the days of the month for the purpose of telling the fortunes of various human activities. For *Mā yang rgya rtsis*, see chapters 3 and 4. Being contrary to the claims made by Huang and Chen throughout their writings, the first text of this tradition (= *Rgya rtsis snying bsdus*) appeared in Beijing in the 18th century and then began by Mā yang Bzod pa rgyal mtshan in Amdo who was possibly active in the early 19th century, and the text has no relation to the *Rgya rtsis chen mo*. Rather, it is a duplicate of the eclipse calculation algorithm displayed in a Chinese text called the *Lixiang kaocheng*. In other words, the *Mā yang rgya rtsis* is not an astronomical system but an astronomical technique for eclipse calculation. For *rgya rtsis* in the lower-right cell, see the following pages in this introduction in which Schuh's articles on *rgya rtsis* / *nag rtsis* are introduced. It should be noted that *rgya rtsis* may include all kinds of astronomy and astrology from China in a broader sense, but *rgya rtsis* as an astrology denotes *nag rtsis* or *'byung rtsis*.

history of the *skar rtsis*. Let me use Schuh to briefly give an introduction of the earlier history of astronomy in Tibet. According to Schuh, some *Kālacakra* methods exploited by Slob dpon Bsod nams rtse mo (1142–1182) and Rje btsun Grags pa rgyal mtshan (1147–1216) show that a complete assimilation to the *Kālacakra* system did not take place until ’Phags pa Blo gros rgyal mtshan’s (1235–1280) time.[2] In other words, the *Kālacakra* calendar became the official Tibetan calendar by ’Phags pa in the second half of the 13th century.[3] Along with ’Phags pa, Bu ston Rin chen grub (1290–1364) is one of the most eminent astronomers in the early period.[4] In the 15th century, remarkable achievements in Tibetan astronomy were made by such *Phug pa* scholars as Grwa phug pa Lhun grub rgya mtsho (15th c.), Mkhas grub Nor bzang rgya mtsho (1423–1513), etc. Further, Mtshur phu ’Jam dbyangs don grub ’od zer (1424–1482) developed the *byed rtsis* calculation

[2] Schuh (1973a: 4-5) and Schuh (1974: 558-9).

[3] Schuh (1973a: 74): “... Abhandlungen des ’Phags pa zur Kalenderrechnung und Astronomie, deren Bedeutung für die Ausbreitung des *Kālacakra* Kalenders in Tibet als sehr hoch eingeschätzt werden muss, einen ersten schüchternen Versuch der Kalenderreform in dieser Richtung dar.” See also Schuh (1974: 557-8).

[4] Schuh’s appraisal for Bu ston’s *Mkhas pa dga’ byed* is seen in Schuh (1973a: 32-3): “Im Unterschied zu den bisher aufgeführten Werken versucht Bu ston in diesem seinem Werk vor allem die Bedeutung der verschiedenen Kalkulationen der *grub rtsis* und der *byed rtsis* deutlich aufzuzeigen.” Also see Schuh (1973a: 80): “Erst die mathematisch unkomplizierte Lösung der hier gegebenen Aufgabenstellungen, die als „Analyse nach den drei Tagesarten“ (*zhag gsum rnam dbye*) einen zentralen Teil der *skar rtsis* der späteren Zeit darstellt, hat die erste groβe Kalenderreform im Sinne der Verwendung der *grub rtsis* für die praktische Kalenderrechnung möglich gemacht.” For the structure and contents of *Mkhas pa dga’ byed*, see Ōhashi (1984) and Ōhashi (1986).

of ’Phags pa.[5] The climax was reached by the *Phug pa* scholar Sde srid Sangs rgyas rgya mtsho (1653-1705).[6]

Second, *rgya rtsis*, which represents all kinds of astrological and astronomical traditions from China in a broader sense[7] and includes the astrological *nag rtsis* (Sino-tibetan divinational calculations), *’byung rtsis* (elemental calculation), etc.[8] Various types of *rgya rtsis* can be assumed according to different time periods. In the early period, Schuh mentions ’Phags pa’s *Rtsis kyi gtsug lag dang mthun par nges pa* in which criticism toward *rgya rtsis pa* (Schuh (1973a: 7): “die in Tibet bekannten chinesischen Astronomen”) is found.[9] In a later period, the division between new and old *rgya rtsis* (T. *Rgya rtsis gsar*

[5] Schuh (1974: 562-5).

[6] Unfortunately, the modern research into Tibetan astronomy and astrology still remains in Schuh’s correct but terse sketch. In fact, some giants in the field of astronomy and astrology should be studied to clarify the formation and development of *skar rtsis* in the earlier period within a *skar rtsis* frame and within a broader *Kālacakra* frame. For example, the following important scholars may be listed: Karma pa III Rang byung rdo rje (1284–1339), G.yung ston Rdo rje dpal (1284–1365), Dol po pa Shes rab rgyal mtshan (1292–1361), Mnga’ ris Chos rje Jo nang Phyogs las rnam rgyal (1306–1386), Mkhas grub rje Dge legs dpal bzang po (1385-1438), Byang bdag Rnam rgyal grags bzang (1395–1475), Karma ’Phrin las pa (1456–1539), Dpa’ bo Gtsug lag phreng ba (1504–1566), Karma pa VIII Mi bskyod rdo rje (1507–1554), etc. In the same vein, Henning’s research into ’Gos Lo tsā ba Gzhon nu dpal (1392–1481) deserves praise. For his research, see Henning (2007: 307-21).

[7] Schuh’s definition of *rgya rtsis* is as follows: Schuh (1973a: 15): “... dass dem Kompositum *Rgya rtsis* eine Mehrdeutigkeit zukommt und dass es insbesondere auch die chinesischen Divinationskalkulationen (*Nag rtsis*) mitbezeichnen kann.” Also see Schuh (1973a: 17): “Zusammenfassend formuliert bezeichnet also *Rgya rtsis* die chinesischen Kalkulationswissenschaften schlechthin und insbesondere terminologisch die chinesische rechnende Astronomie und Astrologie.”

[8] For relevant information, see the synopsis of Schuh (2004) in this introduction.

[9] For the introduction of the criticism, see Schuh (1973a: 6-7). For an etymological explanation of “*rgya rtsis pa*,” see Schuh (1973a: 15): “Allerdings erwähnt schon ’Phags pa die *Rgya rtsis pa,* und meint damit die chinesischen Astronomen und Astrologen, und die gesamte hier berücksichtigte *Rtsis* Literatur bezeichnet

rnying) emerges according to *lo 'go*, and *Mā yang rgya rtsis,* which is the astronomical tradition from Qing China (Man. Daicing gurun / M. Čing ulus. Manchu dynasty), appears. The term *ser rtsis* is also seen in later Tibetan texts. It may mean "Qing imperial calendar."[10]

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im allgemeinen mit *Rgya rtsis* die chinesische Astronomie und Astrologie." I raise three points at this juncture. First, as van der Kuijp (2004) joins Schuh (1973a), it should be noted that Schuh's (1973a) explanation lacks information of whether *rgya rtsis pa* was (were) active in Tibet or in China. See van der Kuijp (2004: 14, n. 40): "The term *rgya rtsis pa* is ethnically ambiguous, for it can refer to such an individual who is Chinese (*rgya* [*mi*]), or to a Tibetan who does Chinese (*rgya* [*nag gi*]) astrology." Second, regarding 'Phags pa's real use of the *rgya rtsis* calendar in his writing and the level of understanding of the contemporary Chinese astronomy, Chen2 (2006: especially 368-9) may be nice to be mentioned together with Schuh (1973a). Chen2 (2006) worked on 'Phags pa (1992-1993), which is composed of 24 letters of new year's greetings to Qubilai Qaγan, the prince, and the queen written from 1255 C.E. (T. *shing mo yos*) to 1279 C.E. (T. *sa mo yos*): 'Phags pa understands that there is a difference between Tibetan and Chinese calendar in terms of *lo 'go*. Chen2 (2006) suggests that, meanwhile the first month of *Shoushili* (授時歷), the official calendar of Yuwan ulus (Yuan dynasty), is equivalent to *mchu zla ba* (1st month according to the currently used Tibetan *Kālacakra* system), — Schuh (1973a: 6-8, 32, 102) is clear on that point by his research into 'Phags pa's *Rtsis kyi gtsug lag dang mthun par nges pa.* — that of the Tibetan *Kālacakra* calendar, which was being used at that time in Tibet, may be *smal po'i zla ba* (= *mgo zla*. the 11th month), given the 12th letter indicating *sa pho 'brug gi lo smal po'i zla ba la* (See 'Phags pa [1992–1993: 794-5]). His explanation is as follows: the letter was intended to greet the Chinese new year *sa pho 'brug* (Ch. *wuchennian* 戊辰年) but the Tibetan *sa pho 'brug* (1268 C.E.) is already there in the phrase. If it is understood as "in the eleventh month of 1268 C.E.," there is no way to understand it. Therefore, he suggests that if *smal zla* is the beginning month of the year according to 'Phags pa's system—more accurately, the first day of the *smal zla* is taken as the first day of the year— the sentence will be understood as "in the first month of the year of *sa pho 'brug,*" and the problem will be solved. Because of not much remaining textual evidence, it is difficult to refute his claim, but we should keep an eye on this issue. — Of course, Schuh (1973a: 8) would not agree with his claim. Then, how to understand the sentence? — Also for the issue of *lo 'go*, see Bsam 'grub rgya mtsho (2011: 61-3) [= *Bod rgya tshig mdzod chen mo* (2000: 2806-7) = Tshul khrims rgyal mtshan (2009: 368-9)]: according to Bsam 'grub rgya mtsho's (2011) classification, one more possibility used by Sa skya pa may be raised: *hor zla bcu ba'i mar ngo* (the 16th day of the tenth *hor zla*) is taken as the first day of the year. However, I have never encountered the case in Tibetan literature, which means that I do not know from when Sa skya pa scholars began to use the system in Bsam 'grub rgya mtsho (2011: 62). Third, as Schuh (1977: 170) and van der Kuijp (2004: 15) argue, 13th–14th century Tibetan imperial preceptors (Ch. *dishi* 帝师) in *Yuwan ulus* use Chinese calendar in edicts and decrees (Ch. *fazhi* 法旨).

[10] One of the examples of the use of this term is seen in Gser tog (1982: 234); see below pp. 106-7.

MODERN SCHOLARSHIP

Several scholars have attempted to reveal the nature and features of Tibetan astronomy. Let me briefly introduce them under a broader frame of *skar rtsis* and *rgya rtsis*.

I should first mention Schuh, who, in a *bona fide* sense, first began research into Tibetan *skar rtsis* and *nag rtsis*. Let me first deal with his research into *skar rtsis*. He produced a monumental work titled *Untersuchungen zur Geschichte der tibetischen Kalenderrechnung* (1973a), showing mastery of tibetan *rtsis* literature and calculations, through which the features and characteristics of *skar rtsis* have been clarified.[11] In it, he combines philological and historical concerns with mathematics to do calendrical research from the chronological perspective. The tables included in the second part of the book epitomize his main concern, i.e., how to match Tibetan calendar dates of different traditions with Gregorian and Julian dates.[12] Within these calendars, the dates, according to the New (m = 1A in his notation) and the Old (m = 1B) *Phug* system (both *grub rtsis*), the *byed rtsis* calendar based upon the Kālacakra (m = 3), and the *byed rtsis* calendar of ’Phags pa (m = 4) are given with the Gregorian date from 1027 C.E. to 1973 C.E. Schuh (1973a), meanwhile, places significant emphasis on the 15th century; thus, later

[11] His works on *skar rtsis* include Schuh (1970), (1973), (1973a), (1974), (2008), (2012), (2012a), etc. All of them will be mentioned.

[12] For table instructions, see Schuh (1973a: 131-41). For the significance of Tibetan calendar in relation to Tibetan history, see Schuh (1974: 554) who emphasizes that the conversion of the Tibetan dates with the Gregorian dates is critical in historical research.

period astronomical achievements are tersely described.[13] Recently, he published a four volume compendium in which he included a useful glossary and technical vocabulary (Schuh (2012)) and his most up-to-date writing (Schuh (2012a)). The basic frame is not different from that of Schuh's (1973a), and articles are continuously published online on his website.[14] Some information has been added, but mostly not much progress has been made from his seminal work (Schuh (1973a)). His glossary on Tibetan astronomical and astrological terms (Schuh (2012)) is a contribution to the modern research into Tibetan astronomy.

Because I will continuously use his research into *skar rtsis*, I, in this section, confine myself to briefly summarizing his works on *nag rtsis*. On the general history of *nag rtsis* from the earlier period to the 5th Dalai lama Ngag dbang blo bzang rgya mtsho (1617–1682), Schuh (2004) must be first mentioned. It deals with the transmission and systemization of *nag rtsis* in terms of politics. His explanation is as follows: the 5th Dalai

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[13] Schuh's emphasis on the 15th century is given to the perfection of *grub rtsis* by *Phug* system, *zhag gsum rnam dbye, mgyogs rtsis,* etc. See Schuh (1973a: 21): "Aus dieser Spannung (the tension between *grub rtsis* and *byed rtsis*) heraus wurde eine Veränderung der *Kālacakra Astronomie* möglich, die sich als Rekonstruktion der wahren *Siddhānta*-Astronomie verstand und im 15. bis 17. Jahrhundert mit der vollständigen Ausbildung der *Grub rtsis,* d.i. die klassische lamaistische Astronomie und Kalenderrechnung, einen Höhepunkt und Abschluβ gefunden hat." Also see Schuh (1973a: 84): "Diese gleichberechtigte Verwendung der drei Tagesarten bzw. drei Zeitmaβsysteme zur Formulierung der Bewegungsgesetze der Planeten impliziert, ... , eine Reihe von Aufgabenstellungen, deren Lösung als "Analyse nach den drei Tagesarten" (*zhag gsum rnam dbye*) einen zentralen Teil der *Skar rtsis* seit dem 15. Jahrhundert bildet." Schuh (1973a: 87): "Für die *Skar rtsis* der *Phug pa* Schule der zweiten Hälfte des 15. Jahrhunderts ergibt sich daraus ein Dreifaches, nämlich Ansätze zu einem Kalkül der mittleren Bewegung der Planeten, der Gebrauch von Schnellkalkulationen (*mgyogs rtsis*), bei denen mit Hilfe von Tabellenwerken der Rechenaufwand wesentlich verkürzt wird, ..." Also see Schuh (1974: 562-3).

[14] Schuh, http://www.tibet-encyclopedia.de/astronomie.html

lama's introduction of the *nag rtsis* after his visit to the Manchu court in 1653 is a great historical event which demonstrates the relationship between politics and astronomy in Tibet as seen in the 5th Dalai lama's seals: "…. Wie sollte sich der 5. Dalai Lama als Herr der buddhistischen Welt vor diesem Hintergrund gegenüber dem mehrheitlich nicht-buddhistischen, machtpolitisch aber aufstrebenden China und seinem nicht-buddhistischen Kaiserhaus positionieren? Den Schlüssel zu dieser Frage liefert uns möglicherweise eine Wissenschaft, die bei den tibetischen Geistlichen der führenden neuren Schulen des tibetischen Mittelalters praktisch keine Bedeutung hatte, nämlich der *Nag rtsis*, die auch *'Byung rtsis* "Kalkulation der Elemente" genannt wird und die wir hier als sino-tibetische Divinationskalkulationen bezeichnen."[15] Thus, Schuh traces an earlier history of the Sino-Tibetan traditions in Tibet. He argues from the philological viewpoint that *nag rtsis* dates back to the Yar klungs Dynasty (7th c.–9th c.) and played an important role in the daily lives of mediavel Tibetans, being mostly transmitted by the Rnying ma pa.[16] The *Blon po bka'i thang yig*, which was rediscovered by the 14th century Gter ston O rgyan gling pa (1323–?), states that the *nag rtsis* was transmitted by Mañjuśrī in Wutai Mountain in China and that it is a field of science that does not lead sentient beings to the enlightenment. Therefore, Tibetan Buddhist sects began to regard the *nag*

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[15] Schuh (2004: 6-7).

[16] Schuh (2004: 11).

rtsis as a non-Buddhist path[17]: "Im Unterschied zu den Rnying ma pa … die neueren Schulen zwar den astronomischen Darlegungen der Astronomie des *Kālacakratantra* große Bedeutung zumaßen, die Lehren der *Nag rtsis* aber konsequent ignorierten."[18] However, this situation began to change upon the 5th Dalai Lama's visit to Qing China in 1653. Five years after his visit to Qing China, he completed the *nag rtsis* text titled *Nyin byed dbang po'i snang ba* in which he includes Qing China as the land tamed by Mañjuśrī especially in the field of the *nag rtsis*. Thus, the Sde srid also states in the *G.ya' sel* that the *nag rtsis* is a field of study blessed by the Buddha. In this way, it was incorporated into the Buddhist world of the Dge lugs pa order.[19] Of course, there existed internal criticism towards *nag*

[17] Schuh (2004: 12-3).

[18] Schuh (2004: 12).

[19] Schuh (2004: 14-5). However, his argumentation may be countered. *Nag rtsis*'s strong ties to the Rnying ma pa and rejection by Dge lugs pa are still unproven. And it may not have been revived by the 5th Dalai lama. Rather, it may have been transmitted without being attached to the religious sects and may have been being researched continuously and sporadically even before the 17th century. For example, see Byang bdag's letter to Mkhas grub, Byang bdag (2) (n.d.: 10a): "This *nag rtsis* emerged during the time when human life span did not decrease, (when they lived) 100 years. … If you have knowledge of Chinese chronology of teaching, please send me an answer to the questions of where is the rotation of *sme ba* currently and how many have passed up to the present since *nag rtsis* appeared." (*nag rtsis 'di / mi rnams tshe lo ma 'gribs* (*sic.* read *'grib*) *pa / brgya pa'i dus su byung ba yin / … rgya* (*sic.*) *pa'i bstan rtsis shes pa yod na / ding sang sme ba bskor res / gang la yod / nag rtsis byung nas ding sang yan la 'das lo du song / dris pa'i lan kyang bskur mdzod /*). This quotation may reveal that the *nag rtsis* was regarded as a field to be studied in the 15th century in which Byang bdag was active. Further, it should be noted that both Byang bdag and Mkhas grub have no ties to Rnying ma pa. In conjunction with this issue, Schuh (2013) presents an instance that counters his previous claim made in Schuh (2004) about the revival of *nag rtsis* by the 5th Dalai lama. Interestingly, there may have existed a parallel history in Mongolia in terms of the continuity of Mongolian divination, see Ho (2012-2013: 137): he regards the divination documents found in the Xarbuxyn Balgas and researched by Elisabetta Chiodo as evidence of an unbroken transmission of Chinese divination in the Mongolian region between the collapse of Yuwan ulus and the beginning of Qing China.

rtsis. For example, in the divination, Kong tse (Confucius. Ch. Kong(fu)zi 孔(夫)子. 551–479 B.C.E.) is described as one of the major disciples of Mañjuśrī who transmitted the divination, thus comprehending the *gto* and *dpyad* rituals.[20] The nonsensical association was disputed by Thu'u bkwan III Blo bzang chos kyi nyi ma (1737–1802) in the *Grub mtha' shel gyi me long*.[21] His other study of *nag rtsis* (Schuh (1972)) was inspired by Macdonald (1963). He examines Dharmaśrī's (1654–1717/8) *Zla ba'i 'od zer*, a work on *nag rtsis* written in 1684, with a focus on the calculation method of the *sme ba dgu*.[22] In it, he points out that Macdonald wrongly placed the system of *sme ba dgu* used in the *Rgya bod yig tshang* by Stag tshang pa Dpal 'byor bzang po, alias Śrībhūtibhadra (15th c.) in the 60 year cycle, and argues that it should be placed in the 180 year cycle ((*brgya dang*) *brgyad cu skor*).[23] He holds that the ignorance of the *sme ba dgu* brought about the difficulty in deciding the year in which the chapter of the Chinese royal lineage in the text was written.[24]

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[20] For more information, see Lin (2005) and Lin (2007).

[21] For the translation, see Geshe Lhundub Sopa (2009: 337). See also Macdonald (1963: 75), Schuh (2004: 20).

[22] For the term, see 'Gyur med rdo rje (2001: 417): "*sme ba dgu* (Ch. *jiugong* 九宫): the nine numeric squares that comprise White One, Black Two, Blue Three, Green Four, Yellow Five, White Six, Red Seven, White Eight, and Red Nine. ... Through the *sme ba dgu*, the Tibetan sexagenary cycle is actually extended to one of 180 years (*sme phreng gsum*)." According to Macdonald's research, the introduction of *sme ba dgu* in Tibet dates back to the early 8th century according to the Sde srid. See Macdonald (1963: 73). For the principle and divinational methods of the term with a background of the Tang dynasty divination, see Sun (2007)

[23] See Schuh (1972: 487ff.). Dharmaśrī (1654-1717) introduces the term *brgyad cu skor* (lit. 80 year cycle) for the 180 year cycle (*brgya dang brgyad cu skor*). It may be misleading without background knowledge on the depiction in Dharmaśrī's *Zla ba'i 'od zer*. See Dharmaśrī (1999: 7a). Also, see Fifth Dalai Lama (2009: 448).

[24] For Macdonald's doubt, see Macdonald (1963: 78ff.). Especially, Macdonald (1963: 79): "« ... Si l'on calcule

According to him, because of her misunderstanding of the *sme ba dgu*, 60 years increased in calculations: the actual year *shing pho stag* where the *srog sme* White Eight is in the center is 1434 according to the 180-year cycle of the *sme ba*. Thus, he concludes that the chapter of the Chinese royal lineage was also written in 1434, not in 1494, and that, given the *Rgya bod yig tshang*, the 180-year cycle of the *sme ba* was used in 15th century Tibet.[25] Schuh (1973c) also may be read together with his previous article Schuh (1972) in which he explains: the 5th Dalai lama states in the *Rtsis skar nag las brtsams pa'i dris lan nyin byed dbang po'i snang ba* that, before the 17th century where the 180-year cycle of the *sme ba* was well-established, the two ways of allocation of the *sme ba* to the year, i.e., the *drug bcu skor*

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le nombre d'années passées depuis lors jusqu'en *chu mo phag* (1263), deux ans et demi après l'avènement de l'empereur Se chen (Qubilai), trois mille quatre cent treize ans ont passé. … Si l'on calcule le nombre d'années écoulées depuis *chu mo phag* (1263) jusqu'à *me pho khyi* (1406), cent quarante-quatre ans ont passé. Depuis (1406) jusqu'à l'année actuelle *shing pho stag* où le *srog sme* huit blanc est au centre, quatre-vingt-neuf ans ont passé (donc *shing pho stag* = 1494); si l'on additionne le tout, depuis la naissance du Maître, en *sa pho 'brug*, jusqu'à la présente année *shing pho stag* (1494), trois mille cinq cent quatre-vingt-cinq ans se sont écoulés». Si l'on se fiait aveuglément à la chronologie de Śrībhūtibhadra, il faudrait admettre que ce chapitre a été rédigé un *rab byung* plus tard que le reste du *Yig tshang.* Cependant, une première constatation nous met en garde: l'addition finale de Śrībhūti est fausse de soixante ans: 3414 + 144 + 89 = 3645 et non 3585. D'òu proviennent les soixante ans excédentaires?" (Her figure 3414 possibly derives from 2150 (B.C.E.) + 1263 + 1 = 3414). Here, aside from Schuh's corrections, we encounter a problematic situation: If we can safely assume that Stag tshang pa follows Sa skya paṇḍita's (Sa skya pa's) *bstan rtsis* which states that 2213 B.C.E is the year of Buddha's birth, 2179 B.C.E is the year of his enlightenment, and 2133 B.C.E. is the year of his *nirvāṇa*—for relevant information, see Seyfort Ruegg (1992: 272-3)—no match is evident. One of possible reasons is Stag tshang pa's miscalculation: 1434 – (x + 1) = 2133 B.C.E. x = 3566, i.e., 3566 years, not 3583, have passed from Buddha's *nirvāṇa*. Another similar mistake is seen in Sørensen (1986: 255-6, 298-9): Bsod nams rgyal mtshan also uses Sa skya pa's *bstan rtsis*. His calculation is problematic, too: 1260 C.E. (the year of Qubilai Qaγan's ascending to the throne) – (3258 (the elapsed years from Buddha's *nirvāṇa* to the year of Qubilai Qaγan's ascending to the throne) + 1) = 1999 B.C.E. This does not match Sa skya pa's *bstan rtsis*. Or, x − (3258 + 1) = 2133 B.C.E.. Then, x = 1126 C.E. In this case, Bsod nams rgyal mtshan presents the year of Qubilai Qaγan's ascending to the throne as 1126, not 1260, which may mean meager understanding of the Mongolian history by him and contemporary Tibetans.

[25] Schuh (1972: 501-2): "Der Gebrauch der oben erläuterten Korrelationen der Anfangsjahre der 180-ziger Zyklen für das 15. Jahrhundert lässt sich mit einer Angabe im *Yig tshang mkhas pa dga' byed* belegen."

(60 year cycle of the *sme ba*) and the *brgya dang brgyad bcu skor*, existed simultaneously: Some texts like the the *Rin chen gsal sgron*[26] are based upon the *drug bcu skor*; meanwhile, the Phag mo gru rulers adopted the *brgyad bcu skor* in the 15th century.[27] Therefore, special attention needs to be given in order to calculate the year on the basis of the *sme ba*. In the next writing, Schuh (1973d) tackles *'byung rtsis* in which Chinese elemental relations of friend (Ch. *xiangsheng* 相生) and enemy (Ch. *xiangke* 相剋) become the fundamental principles.[28] The *nag rtsis* is an indicator of Tibetan customs and rituals. Schuh notably emphasizes that the *nag rtsis* is characterized by cultural syncretism between China and Tibet. In the same vein, he deals with the *rgya nag rdel skor*, which is well described as the last calculation method of the *keg rtsis* in Blo bzang tshul khrims rgya mtsho's (alias Lha mo tshul khrims (1889–1958)) *Rgya rtsis dge ldan mkhas pa'i phyag rgyun du bstar ba'i rdel 'grem dpag bsam ljon shing* written in 1921 C.E.. The *rgya nag rdel skor*,[29] whether it is circle or cross, is given according to the elemental relations whose

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[26] Schuh (1973d: 395, no. 15): "Dies ist eines der grundlegenden Werke der *Nag rtsis*, die von dem zweiten Kham pa khra mo ins Tibetische übersetzt worden sein sollen."

[27] Schuh (1973c: 288): "... eine Zuordnung von Jahr und *Sme ba*, die in einer Datumsangabe nach der mittleren Reihe der *Sme ba* vorgegeben ist, zur Identifizierung dieser Jahresangabe für die Epoche des tibetischen Mittelalters nicht mit Sicherheit verwendet werden kann, da ihr möglicherweise eine Verwendung des Sechzigerkreises zugrunde liegt. Liegt aber eine Zuordnung nach der 1. und nach der 3. Reihe der *Sme ba* vor, ... , dass sie auf einer Kalkulation mit dem Achtzigerkreis basiert. In diesem Fall kann der Zyklus von 180 Jahren zur Identifizierung der Jahresangabe verwendet werden."

[28] For a detailed explanation, see Tseng (2005: 28-30).

[29] 'Gyur med rdo rje (2001: 414): "*rdel skor* (stone circle); divinatory pebbles: Pebbles were deployed in charts representing the diverse relationships formed by the elements, whether in the context of natal horoscope or of divinations concerning marriage, obstacle years, ill health or death. ... In the schematic

origin is Chinese astrology. Thus, Schuh argues that E. Schlagintweit (1835–1904) and L. A. Waddell's (1854–1938) researches on the *nag rtsis* do not illuminate its religious meaning, which is related to rituals such as marriage, funeral, burial, etc.[30]

All in all, Schuh, being equipped with the best philology and astrological and astronomical knowledge, has pioneered the new territories of *skar rtsis* and *nag rtsis*. His marvellous scholarship has been, is, and will be an inspiration for the research of the Tibetan *rtsis*.

Huang Mingxin has produced books and articles on Tibetan astronomy, with the colloboration of Chinese ancient astronomy specialist Chen Jiujin, since the 1980s. Both authors learned from Bsam 'grub rgya mtsho (1923–2006), one of the greatest astronomers of the 20th century at Bla brang bkra shis 'khyil. The quality work Z*angli de yuanli yu shijian* is a joint work by the two. It is a textual research on the two crucial astronomical texts, one from *skar rtsis*: Phyag mdzod Gsung rab's *Rigs ldan snying gi thig le*,[31] the other from the *Mā yang rgya rtsis*[32]: *Rgyal khab chen po pe cing gnas pa'i yul gru gtso*

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charters or grids that are employed today, the white pebbles are represented by circles and the black pebbles by crosses."

[30] Schuh (1973b) is also based upon this criticism.

[31] The author Phyag mdzod Gsung rab (active in early 19th c.) is Shing bza' Blo bzang dar rgyas rgya mtsho's (1752-1824) *phyag mdzod*. He mainly functioned at the monastery of Rwa rgya and his *Rigs ldan snying gi thig le*, which was edited and translated in Huang and Chen (1987), is known to be stored at this very monastery. The epoch of the text is 1827 C.E. and then changed into 1927 C.E. by Mkhyen rab nor bu (1883–1962) at Bod ljongs sman rtsis khang. Since Phyag mdzod (1976) whose epoch was changed by Mkhyen rab nor bu does not indicate any sign of the original authorship, both Schuh and Henning (2007) are ignorant of the existence of the original work by Phyag mdzod. Schuh (1973a: 43): "Bstan bcos *Vaiḍūrya dkar po dang nyin byed snang ba'i dgongs don gsal bar ston pa rtsis gzhi'i man ngag rigs ldan snying gi thig le.* Der Verfasser ist der circa 1882 geborene Mkhyen rab nor bu." Schuh (1973: 287-90): *Rigs ldan snying gi thig le*: No. 305/ Hs. sim. or.

bor byas te nyi zla gza' 'dzin brtags tshul.[33] It is an ideal textbook for anyone who is interested in knowing Tibetan *rtsis* calculations. The book clearly presents Tibetan astronomical concepts and theories. Most of all, the best combination between the Tibetologist and specialists on ancient Chinese astronomy works greatly for the explanation of the Tibetan *Mā yang rgya rtsis* tradition, which is derived from the Qing China calendrical astronomy.

Yum pa (alias Yum skyabs rgyal), director of Bod ljongs sman rtsis khang gnam rig skar rtsis zhib 'jug khang, is a primary disciple of the aforementioned Bsam 'grub rgya mtsho. He also worked together with Na lendra'i mkhan po Tshul khrims rgyal mtshan (1933-2002) and Byams pa 'phrin las (1929-2011) in Lhasa. Based on my personal experience, he is the only Tibetan *rtsis* professional among Tibetans in this century. His contributions are as follows: first, he has excavated and published new astronomical texts. For example, he recently edited and published Sum pa mkhan po Ye shes dpal 'byor's

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JS (Handschrift Simologica Orientalia Janert/Schuh) 614. The mistake has been pointed out by Seyfort Ruegg (1992: 277, no. 69). For the authorship of the original *Rigs ldan snying gi thig le*, see also Bsod nams rin chen (2009: vol. 1, 32-3) and Bsam 'grub rgya mtsho (2012: 699).

[32] The *Mā yang rgya rtsis* is a Tibetan duplication of the part of eclipse algorithm in the *Lixiang kaocheng*, which is the sinocized Western astronomy in Qing China. For the information, see chapter 4. The appellation is not common in Tibetan text. It is usually just denoted as *rgya rtsis*. As seen above, *rgya rtsis* may mean all kinds of astronomy and astrology of Chinese origin in a broader sense. Thus, I use the term *Mā yang rgya rtsis* to tell it from the broader and encompassing term, *rgya rtsis*.

[33] Among Tibetan astronomers and scholars, this text whose epoch is 1744 is simply known as *Rgya rtsis snying po bsdus pa* (= *Rgya rtsis snying bsdus*), and its authorship has been attributed to Mā yang Bzod pa rgyal mtshan, which is problematic. See chapter 4.

(1704-1788) astronomical texts, including the *Dga' ldan rtsis gsar/ Dge ldan rtsis gsar*[34] and Gser tog Blo bzang tshul khrims rgya mtsho's (1845–1915) astronomical texts.[35] Thus, he has found new astronomical literature. For example, he found the Sde srid's *bu yig*, *Bstan bcos chen po bai ḍur dkar po'i cha rkyen du gtogs pa'i legs par bshad pa bu dpe por gcig*, which has been mentioned in some Tibetan *rtsis* literature, but its existence had not been known until he discovered it.[36] Further, he digitalized the so-called *Rgya rtsis chen mo* stored in the Potala palace.[37] Second, he has developed software for calendrical calculation, named *Bod kyi gnam rig skar rtsis rig pa'i brtsi byed ma lag* (not publicized yet), by using Visual Basic, C++, and Fortran. *Lnga bdsus*, Rāhu, *spyi zhag*, *sgos zhag*, etc.[38] of each day in the *grub rtsis*

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[34] I believe that his edition has been published as of 2015 by Si khron mi rigs dpe skrun khang, but I have never seen the hard copy. I use its pdf which Yum pa personally gave me. He used following four versions for the *ma* and *bu* each; two xylographs: one from TBRC and the other from Se ra monastery (originally Potala *par ma*) and two manuscripts: one from Amdo scholar Dam chos, the other from the Library of Nor bu gling ga (Nor bu gling ga'i dpe mdzod khang). Even if the manuscripts are relatively clearer, they are later copies with many typographical and scribal errors. Thus, he primarily used the xylographs to present the modern editions. At any rate, it is intriguing for me to learn that there exists the clearer xylographs of Sum pa mkhan po's writings than the well-known xylograph from Usu-tu Monastery in Kökeqota, Inner Mongolia. However, it is not known that Sum pa Mkhan po's *gsung 'bum* exists as a clearer xylograph format in its entirety.

[35] See Gser tog (2015).

[36] See van der Kuijp (2012: 2). The *bu yig* text for the *Vaiḍūrya dkar po* was found by Yum pa in the old Sman rtsis khang in front of the Jo khang, Lhasa.

[37] See van der Kuijp (unpublished (2): 2-5), which is the only English article with the general introduction to this text and its Mongolian original *Tngri-yin udq-a*.

[38] For *lnga bdsus* and Rāhu, see chapter 4. For *spyi zhag*, see Bsam 'grub rgya mtsho (2011: 100-1), Schuh (2012: 1464): "Zahl der seit Epoche vergangenen natürlichen Tage (*nyin zhag*)". For *sgos zhag*, see Bsam 'grub rgya mtsho (2011: 101), Schuh (2012: 1348): "Für jeden Planeten und die Sonne die Zahl der Tage, die seit dem Durchlauf des jeweiligen Planeten durch den Nullpunkt der Ekliptik (*lug khyim*) vergangen sind".

(m = 1A in Schuh's notation with correct leap month)[39], *byed rtsis* (m = 2 in Schuh's notation), and *Dga' ldan rtsis gsar* (m = 10 in Schuh's notation) are easily output with it. Tibetan astronomical calculations are based upon four fundamental arithmetic operations, although they are not simple in some cases. The simple and repetitive calculations may be a waste of time because a computer can save us a lot of time and energy. Furthermore, calculational tables in Tibetan astronomical texts, which are used for real calculations, are subject to errors due to handwriting, calculational errors, etc. In that sense, he has made a significant contribution to enhancing the accuracy of calculations.

Edward Henning has worked on Tibetan astronomy for decades. His monograph *Kālacakra and the Tibetan Calendar,* which is an excellent work from the perspective of modern mathematics, is the most updated research that includes the Tibetan calendar and ephemeris. Throughout the book, he tries to clarify theory and the rationale for the main calculations of Tibetan astronomy. With a tenacious and inquiring mind, he probes and tries to make sense of numbers given in astronomical texts and tries to explain possible theories hidden behind the numbers and formulars. The reading of the main verses of the first chapter of the *Laghukālacakra* and *Vimalaprabhā*, which is presented in chapter 5, in the monograph and the thorough exposition on the relationship between the *Kālacakra* texts and later interpretations of them in Tibetan astronomical writings,

[39] This can compensate for the defects in the intercalation in the tables (1973a: *1*-*239*) in Schuh (1973a), although these correctly output *lhag chad*. For the problem in Schuh's tables, see below no. 432.

which penetrate the monograph, are extraordinary.[40] Nevertheless, it should be cautiously used because Tibetan rationale and astronomical background knowledge and context may be different from the modern astronomical rationale on which the monograph is based. His explanation will be able to be reinforced after confirming with real Tibetan astronomical texts. Further, contrary to the fact that he is equipped with a mathematical background, he may lack in the philological strictness Tibetology requires. His use of Tibetan materials is loosely tied to the Tibetan original text. His other contribution is software comparable with the aforementioned Yum pa's software: he created software that enables us to easily obtain the values of *lnga bdsus*, Rāhu, *spyi zhag*, *sgos zhag*, etc. of a specific date.[41] His software is designed to calculate the values by Generalized *Phug* system (from – 1000 (= 1001 B.C.E.). m = 1A in Schuh's notation), Generalized *Mtshur phu* (from -1000. based upon Kong sprul Blo gros mtha' yas's (1813-1899) *Rtsis kyi bstan bcos nyer mkho bum bzang las skar rtsis kyi lag len 'jug bder bsdebs pa legs bshad kun 'dus*), Generalized Error Correction (from -2000. 'Gos Lo tsā ba Gzhon nu dpal's

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[40] Several modern scholars worked on the arcane chapter I. For example, Toganoo Shoga translated the *D.* edition *Laghukālacakra* and *Vimalaprabhā* in the 1940s, and his note was published posthumously in Toganoo (1989). He translated the most part of chapter I. But, because he has no knowledge on astronomy, the translation is not reliable. Then, Banerjee (1959) presented the translation of the first chapter of the *Laghukālacakra* on the basis of the Sanskrit manuscipts from Cambridge University Library, Royal Asiatic Society of Great Britain and Ireland in London, and K. P. Jayaswal Research Institute in Patna, but it is not a great addition to the research into the *Kālacakra* astronomy. Newman (1987) translated *Laghukālacakra* chapter I, verses 1-27, and verses 128-170 together with some verses of *Vimalaprabhā* chapter I. He did not work on the essential verses for the astronomical theory and practice. So, no substantial contibution to the understanding of the *Kālacakra* astronomy has been made before Henning (2007), which is the only work worth being referenced.

[41] For the instruction and explanation of the software, see Henning's web page http://www.kalacakra.org/calendar/os_tib.htm.

(1392-1841) *Rtsis la 'khrul pa sel ba*), *Mkhas pa'i snying nor* (from 1796. Thu'u bkwan III's *Mkhas pa'i snying nor*)[42], Sum pa Mkhan po's *Dga' ldan rtsis gsar* (from 1747. m = 10 in Schuh's notation).[43] This software surely saves us from spending simple repetitive arithmetic operations such as Yum pa's software does.

Last but not least, research into *nag rtsis*, astronomy of Chinese pedigree, includes 'Gyur med rdo rje,[44] Tseng Teming (aka Zeng Deming), etc.[45] The former

[42] The authorship is problematic. See the *Mkhas pa'i snying nor* included in Thu'u bkwan III's gsung 'bum Vol. 9 (*ta*) (*Zhol par ma*) (2000: 35b-36a): According to the colophon of the text, a monk who calls himself Btsun gzugs snyoms las pa 'Jam dbyangs dgyes pa'i gzhon nu composed it and made his disciples such as Gtsang ston Bstan pa dar rgyas, etc, who are experts in real practice, calculate and write the values. ... Then, 'Jam dbyangs dgyes pa'i gzhon nu is Thu'u bkwan III's another name? In Thu'u bkwan III's *gsung 'bum*, Mi pham zla ba's (1767-1807) *dkar chag* of *Mkhas pa'i snying nor*, *Rtsis kyi bstan bcos mkhas pa'i snying nor gyi dkar chag legs par bshad pa chos dung g.yas 'khyil,* is also included but there is no information verifying the authorship of *Mkhas pa'i snying nor*. Mi pham (2012a: 277) delivers some information on the authorship: "*Rtsis kyi bstan bcos mkhas pa'i snying nor*: it is said that monk (T. *btsun gzugs pa*) 'Jam dbyangs dgyes pa'i gzhon nu composed. ... It is said that Thu'u bkwan III Vajradhara summarized its catalogue written by Mi pham zla ba (= Mi pham dbyangs can dga' ba'i blo gro), and wrote." (*rtsis kyi bstan bcos mkhas pa'i snying nor zhes /... / btsun gzugs pa 'jam dbyangs dgyes pa'i gzhon nus mdzad gsungs / ... / de'i dkar chag ... / mi pham zla ba'am / mi pham dbyangs can dga' ba'i blo gros kyis ... bris pa / thu'u kwan rdo rje 'chang gis bsdus zhing brtsam zhes so /*). Given the above passage, the original author is the unidentified 'Jam dbyangs dgyes pa'i gzhon nu and 'Jam dbyangs dgyes pa'i gzhon nu is a different one from Thu'u bkwan III Blo bzang chos kyi nyi ma. After browsing TBRC, I found that the unidentified 'Jam dbyangs dgyes pa'i gzhon nu appears again in a *blo sbyong* text named *Blo sbyong tshigs brgyad ma'i 'khrid yig* included in Thu'u bkwan III's *gsung 'bum* Vol. 3 (*ga*) (*zhol par ma*). The colophon reads as follows: "Monk (*bstun pa*) 'Jam dbyangs dgyes pa'i gzhon nu 'Jigs bral smra ba'i nyi ma who is devoted to the teachings of old and new *Bka' gdams pa* composed it." (*... bka' gdams gsar rnying gi bstan pa la mos pa'i btsun pa 'jam dbyangs dgyes pa'i gzhon nu 'jigs bral smra ba'i nyi ma zhes bya bas ... sbyar ba'o /*). Is he Blo bzang chos kyi nyi ma? To decide it, reading his biography may work. Let me leave the issue aside for future research. It has been commonly believed that *Mkhas pa'i snying nor* is a Thu'u bkwan III's work, but there remains the uncertainty on the authorship. Nevertheless, for convenience's sake, I take it as a work of Thu'u bkwan III.

[43] His explanation of the term "generalized" is not found on it, but according to him, "generalised" means that it uses no textbook epoch value, but an epoch of year -1000. This is so that all epochs and events such as in the Buddha's lifetime can be calculated. The two traditions out of the five, i.e., *Dga' ldan rtsis gsar* and *Mkhas pa'i snying nor*, which are not addressed "generalized," adhere to their real epochs, 1747 C.E. and 1796 C.E., respectively.

[44] 'Gyur med rdo rje (2001).

worked on the *nag rtsis* parts of the Sde srid's *Vaiḍūrya dkar po*[46] and Dharmaśrī's *'Byung rtsis man ngag zla ba'i 'od zer*; the latter worked on Blo bzang tshul khrims rgya mtsho's *nag rtsis* text *Dpag bsam ljon shing*.

Overall, not many brilliant works have been intermittently publicized, and the time-honored Tibetan *rtsis* tradition remains understudied. It is also true that, in spite of the many valuable intellectual texts that have been produced in the field of *rtsis*, the abstrusity and expertise hinder modern researchers from studying it.

CHAPTER OUTLINE

Among many topics in *rtsis*, I focus on the Tibetan way of understanding and interpretation of eclipse calculations, especially with a focus on the 18th century.[47] Then,

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45 Tseng (2005).

46 For a detailed analysis of the contents of the *Vaiḍūrya dkar po*, see Schuh (1973: 266-77).

47 The early period may not appropriate for the research into Tibetan eclipse calculation. Simply, not many materials exist and the knowledge on eclipse is also meager. For example, Śākyaśrībhadra's (1127-1225) short text on eclipse calculation *Nyi zla 'dzin pa'i rtsis* (*P. Bstan 'gyur*, No. 2100 under the title of *Dpal dus kyi 'khor lo'i rtsis kyi man ngag*; *D. Bstan 'gyur*, No. 1385) exists. As for his eclipse calculation, there exists an interesting anecdote between him and Rje btsun included in *Sa skya'i gdung rabs ngo mtshar bang mdzod.* See Ngag dbang kun dga' bsod nams (1986: 79-80); for the Chinese translation, see Chen, Gao, and Zhou (2002: 52). It gives us a feeling that he is not learned in astronomy at all. It seems that his disciple Vibhūticandra is also not a master in astronomy. Vogel (2002) evidences that Vibhūticandra has very limited knowledge on eclipse calculation. For the life and works of Vibhūticandra, see Stearns (1996). Nearly no materials showing the systematic eclipse calculation remain in Tibet, even before 15th to 16th century, as far as I know. In that sense, the later period, for example, the 18th century, in which observational data and empirical knowledge kept accumulating, and Tibetan astronomers were able to absorb new elements from other traditions, may be a good topic for the study of the Tibetan eclipse calculation.

why eclipse calculation with a focus on the 18th century? First, within the boundary of astronomical calculations, eclipse calculation is a big part of *skar rtsis* astronomy, while being related to various issues in *skar rtsis*. In other words, eclipse is a nice tool to explain overall issues in Tibetan astronomical research. For that purpose, rather than presenting simply the process or sequence to produce eclipse results, I take the following approach: I explain the context and background of why *skar rtsis* presents certain calculational methods and what Tibetan astronomers' astronomical thoughts and ideas are based upon, how *skar rtsis* evolved by interacting with various knowledge sources. With that line of thinking, I further focused on explaining the background knowledge for eclipse calculation. Second, within the religious frame, I focus on explaining the Tibetan rationale for eclipse calculation. Little study on Tibetan *skar rtsis* has been made thus far from the perspective of religious history. Ultimately, I attempt an interdisciplinary research, which connects astronomy and religion. I present criticism, along with different concepts and ideas for the calculation methods of eclipse and mathematical techniques in the 18th century. I incorporate the mathematical and astronomical knowledge into intellectual and religious context in order to consider the inextricable link and dynamics between Tibetan eclipse calculations and Buddhism as well as to provide understanding of the fundamentals of Tibetan eclipse calculation itself.

My writing is composed of two parts, i.e., part I (chapters 1 and 2) and part II (chapters 3 and 4). Part I concerns religious meaning and the significance of eclipse calculation in Tibet. For the significance of an eclipse in Tibet, it would not be enough to merely mention that eclipse calculation is made because astronomy is one of the 10 sciences (S. *daśavidyā*/ T. *rig gnas bcu*),[48] which are derived from India, because there are Tibetan indigenous interpretations. In chapter 1, first, in terms of Buddhist chronology (*bstan rtsis*), Tibetan astronomers maintain that the Buddha's enlightenment during a lunar eclipse recorded in some Indian Buddhist texts such as *Vinaya*, *Abhiniṣkramaṇa sūtra*, *Lalitavistara sūtra*, etc. should be accurately calculated by backward calculation (*yar log gi rtsis*) based upon calculation methods in the *Kālacakra*.[49] Among many *bstan rtsis*-s in history, I mainly focus on the conflict between *byed rtsis* and *Phug pa grub rtsis*[50] by using Sum pa Mkhan po. The hermeneutics that makes sense of the different Buddhist texts with *Kālacakra* is as follows: *Kālacakra* is superior to the other texts, but both the former

[48] *Rig gnas bcu* (ten sciences), which is the traditional Tibetan method for the classification of sciences, includes *rig gnas che ba lnga* and *rig gnas chung ba lnga*. The former, or the major five sciences, are *bzo rig pa* (S. *śilpakarmasthānavidyā*, technical science), *gso ba rig pa* (S. *cikitsāvidyā*, medicine), *sgra rig pa* (S. *śabdavidyā*, Sanskrit grammar), *gtan tshigs rig pa* (S. *hetuvidyā*, Buddhist logic and epistemology), and *nang don rig pa* (S. *adhyātmavidyā*, Inner science/ Buddhism). The latter, or the minor five sciences are *snyan ngag* (S. *kāvya*, Poetry), *mngon brjod* (S. *abhidhāna*, synonymics), *sdeb sbyor* (S. *chandas*, metrics), *zlos gar* (S. *nāṭaka*, drama) and *skar rtsis* (S. *jyotiṣa*, astronomy). For the textual bases on the classification, see Seyfort Ruegg (1995: 93-147), van der Kuijp (2012: 3). Especially for astronomy, see Seyfort Ruegg (1995: 107-8): Dpal khang lo tsā ba Ngag dbang Chos kyi rgya mtsho (active in 16th c.) recognized the *skar rtsis* as one of the *rig gnas chung ba lnga*. van der Kuijp (unpublished [2]: 4, no. 18): *Vinayavibhaṅga* is the *locus classicus* of the *rig gnas chung ba bco brgyad* (18 domains of knowledge) in which astronomy/astrology is included.

[49] For the use of this term among *Phug pa* scholars, see van der Kuijp (unpublished [2]: 10-11). He renders it as "reverse engineering" with the presentation of such different terms as "*g.yen du log pa'i brtsis*/ *g.yen log gi brtsis*." My finding on the relevant expression is: Byang bdag (3) (n.d.: *passim*), which was written in 1440, uses "*gyen log gi rtsis*." Also read Nor bzang rgya mtsho transalted by Kilty (2004) in which Kilty uses "reverse calculation" for the term.

[50] This dyadic relationship is safe after the 15th century. See also below note 401.

and latter are affirmed. Tibetan astronomers may have thought that they created the compatible system between them, but they did not provide the reason why they should be compatible and why Buddhist texts being incompatible with the *Kālacakra* in terms of chronology were ruled out.

In chapter 2, I argue that eclipse, which evidences the accuracy of a certain astronomical system, influences the performance of the religious rite *gso sbyong.* Tibetan scholars hold that the dates for *gso sbyong* specified in Indian *Mūlasarvāstivāda Vinaya* texts, the 14^{th} and the 15^{th} *nyin zhag* on a fortnightly basis, are basically the 15^{th} *tshes zhag* in *skar rtsis*. The logic is called *zhag mi thub* and works as a way of justifying the accuracy of *skar rtsis* by means of attuning *Vinaya* to *skar rtsis* based upon the *Kālacakra.* In Tibetan *skar rtsis* where an eclipse is supposed to occur on the end of the 15^{th} and on the end of the 30^{th} *tshes zhag* (= 15^{th} *tshes zhag* on a fornightly basis) respectively, the fact that the occurrence of solar eclipses occasionally did not match up with *skar rtsis* dates (*tshes zhag*) was a challenge on a religious level, specifically for the performance of *gso sbyong* because it may mean that the *tshes zhag* is not accurate. Further, it was beyond the explanations justified by the logic of *zhag mi thub*. Especially in 18^{th} century Amdo, where *rgya rtsis* was being circulated, the discrepancy between *skar rtsis* and *rgya rtsis* dates causes Tibetan astronomers to be confused in deciding the date of *gso sbyong*: After encountering the occasions on which solar eclipses occurred on the 1^{st} lunar date according to Chinese calendar, not the 30^{th} *tshes zhag* according to *skar rtsis*, the local performance of *gso sbyong* (*yul bstun gso sbyong*) according to Chinese calendar was added to the time-honored performance based upon *skar rtsis*. To make sense of Indo-Tibetan *Vinaya* practices in

Amdo adjacent to *han* (漢) ethnic China, Sum pa Mkhan po accommodated the Qing China calendar on the basis of the logic of regional difference (*yul bstun gso sbyong*) by referring to *Vinaya* again. He still defended the *Vinaya.* His logic was that the specifications in the *Vinaya* work greatly in other Tibetan areas including Lhasa, even if it may not work in Amdo near to China. In other words, both *Kālacakra* and *vinaya* and Chinese calendar / *rgya rtsis* are affirmed by labeling the former as "general cases" and labeling the latter as "special cases." At any rate, I guess that while *zhag mi thub* is based upon the idea of the accuracy of *tshes zhag*, *yul bstun gso sbyong* basically admits the malfunction of the logic of *zhag mi thub* buttressed by the accuracy of *tshes zhag.*

As is seen from above, the significance of eclipse calculation in the Tibetan context lies in its religious strata, and the religious meanings have made Tibetans keep striving to get accurate results of eclipse calcualtion. This religious frame penetrates through the practice of the Tibetan *rtsis* even when the totally non-religious *rgya rtsis* was introduced and practiced. Through the research into an eclipse, it is verified that religion is Abgrenzung and Voraussetzung for the development and direction of Tibetan astronomy. Accuracy matters in Tibetan eclipse calculation, but intellectual and religious background of why Tibetans seek after calculational accuracy is also important. Being equipped with such religious background knowledge, our next issue would be Tibetans' approach to and efforts for the accuracy of eclipse calculation.

Part II is composed of two chapters dealing with 18th century Tibetan astronomical approaches and mathematical methods for the accuracy of eclipse calculation. Chapter 3 presents framework that may help in the understanding of how Tibetan astronomers deal with astronomical phenomena, especially an eclipse. I divide textual and non-textual[51] knowledge sources. Further, I present my observation and findings on the Tibetan approach to astronomical phenomena in general and then narrow down to the phenomena of eclipse in particular. Generally, *skar rtsis* anchoring in *Kālacakra* religious texts are intermingled and intertwined with non-textual (mostly associated with non-religious) components including observation, empirical knowledge, discussion and debates, and research into other traditions, especially by means of equating and juxtaposing Mongolian and Chinese traditions.[52] Because not much

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[51] I use the term "textual" to indicate Buddhist texts, especially the *Kālacakratantra* corpus. And the "non-textual" elements are those that are not found in the Buddhist texts, but they are not necessarily non-Buddhistic.

[52] I borrow the terms "anchoring" and "intertwining" from architect Steven Holl. In his conception, "anchoring" is the building's integration to land, and "intertwining" is the intermingling of space and time by the interlocking of sound, light, and material, ultimately aiming for the integration of heterogenious and discontinuous spaces. For further understanding, see Holl (2007: 30). To give a context, when building Stretto House in Dallas (completed in 1991), he was inspired by Béla Bartók's Music for Strings, Percussion and Celeste, Sz. 106. See Holl (2007: 150-5), Holl (2007: 30-43), Holl (1996a). To give a brief introduction to Bartók's proportion and tonality for the understanding of Holl's terms, influential but controversial Lendvai's analysis on Bartók, Lendvai (2009) can be used. First, in the case of proportion, Lendvai argues that the first movement of the Bartók's piece uses Fibonacci series and golden section (golden mean/golden ratio. $\approx$ 0.618)—each number in the Fibonacci Series is approximately the golden section of the following number. Second, concerning tonal system, he suggests the three axes system. He analyses that the Bartók's work is based on harmonic functions of tonic, subdominant, and dominant axes with four poles each. Further, each of the three axes has two branches, i.e., "primary branch" and "secondary branch," whose members are "pole" and "counterpole" being substitutable. For this, see Lendvai (2009: 3-5). Going back to Holl's Stretto House, it "anchors" in stretto in a fugue, characterized by golden section, as structural components for the purpose of embodying the overlap of space. It also incorporates heterogenious and discontinuous spaces by means of "intertwining" characterized by infinite but regular tonal substitution in Bartók's music. Analogically, I use the terms, "anchoring" and "intertwining," to present the features of *skar rtsis*: Tibetan *skar rtsis* texts "anchor" in its *locus classicus Kālacakra* by claiming the homogeneity of the religious astronomy, but "intertwine" and interlock with observation, empirical data, research into different traditions, political concern, etc. Also, it should be noted here that "anchoring' is not contradictory to "intertwining." Rather, the former accommodates the latter, making the Tibetan *skar rtsis* system as an integrated entity. Therefore, the two concepts, "anchoring" and "intertwining," justify the

information in the *Kālacakratantra* corpus is included in terms of eclipse calculation, the non-textual elements inherently play a significant role in increasing the accuracy of eclipse calculation in *skar rtsis*. Thereby, Tibetan astronomers "saved the phenomena"[53]—not by theory but by practice. Most of all, the non-*Kālacakra* factors do not overturn the basic information in the *Kālacakra*. No oppositional relationship between textual and non-textual components has been posited in Tibetan history of astronomy. For example, even the observations, which look to betray the contents of the *Kālacakra*, are interpreted in a way of being compatible and congruous to the *Kālacakra.* Empirical knowledge and canonical knowledge are not in conflict. "The non-textual sources" are not opposed to the *Kālacakra*. All the information and knowledge from textual/ non-textual and religious/ non-religious sources are arranged and systemized under the religious frame of the *Kālacakra*. Therefore, it is an essential part of research into Tibetan astronomy to point out that the astronomical meaning of *skar rtsis* has been enriched by means of the interface between textual/non-textual and religious/ non-religious elements. Throughout the process of interface, the authority of a religious superior was given to the *Kālacakra* and bilateral or multilateral affirmation of different knowledge sources was

expansion of knowledge in *skar rtsis* while strengthening the religious *Kālacakra* context. The point will be emphasized continuously.

[53] To save the phenomena (σῴζειν τὰ φαινόμενα), which is an expression coined by Duhem (1861–1916), involves presenting an hypothesis that matches the available evidence without investigating the cause of natural phenomena; see Duhem (1908). For the English translation, see Doland and Maschler (1969).

possible by an unequal and binary relation between the *Kālacakra* and non-*Kālacakra* sources.

Chapter 4, I tackle the Tibetan way of getting accurate results of eclipse calculation by means of focusing on real calculation concepts and methods. This chapter is coupled with chapter 3, in which I present the framework to have access to an eclipse calculation in *skar rtsis*; in this chapter, I focus on the concepts and the eusuing calculations, which are necessary for eclipse prediction. In my conception, they are largely divided into Indo-Tibetan *skar rtsis* and Chinese *rgya rtsis* methods. The reason why I focus on real calculation is as follows: Schuh's stance as a historian, and Henning's modern astronomical approach have contributed to unveiling the features of *skar rtsis* astronomy. Nevertheless, real calculation has yet to be presented. Thus, why does calculation matter? I believe that the arcane and abstruse aspects of the *Kālacakra* corpus may be understood through real use, viz, calculations. I believe that beginning from real calculation in order to understand the esoteric theory and way of depiction in the *Kālacakra* literature may be a good means of approach. In that sense, throughout this chapter, I attempt to maintain the relation of tension between *Kālacakra* and real calculations in *skar rtsis* by means of focusing on the astronomical concepts and ideas and thereby drawing a concrete and tangible picture of *skar rtsis* in an overall sense. Further, an eclipse is an ideal tool for showing pivotal parts of mathematical calculation as well as concepts and theories in *skar rtsis*.

Then, which mathematical methods did Tibetan astronomers use to enhance the accuracy of eclipse calculation? It is necessary to investigate the inner tradition (*skar rtsis*) and the outer traditions (*Tngri-yin udq-a* / *Rgya rtsis chen mo*, *Mā yang rgya rtsis*) as a whole being interconnected in terms of the accuracy of eclipse calculations in order to draw a picture of eighteenth century Tibetan history of astronomy. Eighteenth century Tibetan eclipse calculation is a good topic for showing a comprehensive picture of Tibetan astronomy.

First, the *skar rtsis* method: one of the devices to enhance accuracy was to adjust longitude (T. *longs spyod*) in an arithmetic way, without changing the mean motions (T. *rtag longs.* constants (= fixed values)). The method is called *nur ster* (adding a correction).[54] Another method taken is the change of *rtsis 'phro* (calculation remainder) and *stong chen 'das lo* (elapsed years from a Great Conjunction at the zero point) in an arithmetic means, which helps us to enhance the accuracy of eclipse prediction.[55] Within a broader astronomical and religious frame, the change of *rtsis 'phro* and *stong chen 'das lo* is a part of a bigger all-embracing cosmological Anschauung. The values at the beginning of

[54] Metaphorically speaking, *nur ster* is like moving the goalpost to score a goal. For an explanation, see chapter 4.

[55] *Rtsis 'phro* means "the residual from a calculation." Schuh (1973a) renders the term as "Anfangswerte" (value at the beginning). In the *Phug* cosmological scheme, the correction of *rtsis 'phro* values has been made to the planets revolving on their orbits with their own periods. By the correction of *rtsis 'phro*, the planetary positions were readjusted and consequentally, different values of the *stong chen 'das lo* (= *stong chen las 'das lo* = years elapsed from a Great Conjunction at the zero point (*stong chen* = *stong chen lo tshogs* = great vacuity)) were produced. Metaphorically, the process is like changing runners' starting points on the running track. Then, what significance and effect does the correction of the *stong chen 'das lo* have in Tibetan astronomy? Through it, Tibetan astronomers, especially *Phug pa* scholars, aim for the correspondence between the visible astronomical phenomena such as solstice, equinox, eclipse, etc. verified by *mngon sum* (direct perception) and their calculation results. Also, the Tibetan peculiarity is that they ultimately aim for the integrity of *bstan rtsis* which reflects the Buddha's enlightenment during a lunar eclipse as written in some Buddhist texts. For more explanations of these concepts and methods, see chapters 1 and 4.

calculation (T. *rtsis 'go*, epoch) are altered for the correspondence between mathematical calculations and visible phenomena such as eclipse, solstice, equinox, etc. In the process of the change, Tibetan *Phug pa* astronomers constitute a religious astronomy in which *bstan rtsis*, in which the occurrence of the Buddha's enlightenment during a lunar eclipse is centered, is justified. Thereby, *bstan rtsis* is not only Buddhist chronology but also the cornerstone on which each astronomical system stands. Continuously, A kya Blo bzang 'Jam dbyangs rgya mtsho's (1768-1816) calculation results for the two eclipses in 1785 (*shing sbrul*)/12/15 and 1785/12/30 according to *grub rtsis*, *byed rtsis*, and *dga' ldan rtsis gsar* are verified by me, which has manifold purposes: I demonstrate that the procedure of eclipse calculation in *skar rtsis* is based upon *Kālacakra* methods in terms of vocabulary and mathematics. In addition, I show that the different *rtsis 'phro* values among the different systems cause different eclipse calculation results. Furthermore, I show that *skar rtsis* eclipse calculation is relatively simple and thus, has accommodated and has been corrected by empirical data. It is also noted that, from the modern perspective, parallax, semidiameter, etc. are not considered in *skar rtsis* calculation. This may herald the introduction of the *Mā yang rgya rtsis* at later period filled with modern astronomical knowledge.

Second, the *rgya rtsis* method: there are two texts that should be researched in terms of the accuracy of an eclipse, especially a solar eclipse: *Tngri-yin udq-a* and *Mā yang rgya rtsis*. First, the *Tngri-yin udq-a*, which was created in 1711; some of its chapters are literal translations of the Chinese original *Xiyang xinfa lishu* (1645),[56] which is based upon Western Jesuit astronomy. Thus, it is filled with modern astronomy, trigonometry, geometry, geography, etc. Especially for the calculation of an eclipse, knowledge on coordinate systems, refraction, parallax, semi-diameter of the sun and moon, the distance between the moon and the Earth, etc., which are unprecedented in the Tibetan and Mongolian *skar rtsis* system, were newly introduced in Mongolian. Ensuingly in 1715/1716, its Tibetan translation *Rgya rtsis chen mo* was made by Mongolian Lamas on the basis of it. Straightforwardly speaking, the *Rgya rtsis chen mo* has never been understood or used by Tibetan astronomers. Nevertheless, the reason why I mention it is that it has been wrongly regarded as a forefather of the *Mā yang rgya rtsis* among Tibetan astronomers.[57] In other words, the *Rgya rtsis chen mo* has an astronomical meaning in so far as it is dealt with together with the *Mā yang rgya rtsis*, which will be mentioned below. Second, another *rgya rtsis*: *Mā yang rgya rtsis*,[58] which is a duplication of the procedure of eclipse calculation included in the *Lixiang kaocheng* (歷象考成. published in 1723) with some

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[56] For a brief history of Western astronomical writings in Qing China, see Sivin (1973: 89-92). Also see Hashimoto and Jami (2001: 271-4).

[57] For this, see chapters 3 and 4.

[58] There is no evidence that the founder of the *Mā yang rgya rtsis* tradition was a Tibetan. He may have been a Mongolian Lama, who functioned in Beijing, possibly in the 18th century and knew both Tibetan and Chinese. In chapter 4, I argue that the *Rgya rtsis snying bsdus,* the first work of the tradition presented by Huang and Chen (1987a) was composed in Beijing in the 18th century around its epoch (1744) or during the 13th *rab byung* (1747-1806) for the purpose of enhancing the accuracy of eclipse prediction by means of accommodating the *Kālacakra* and *skar rtsis* knowledge and which then spread to the Amdo area possibly early in the 19th century. Thus, it came to be known as the *Mā yang rgya rtsis*, because it was initiated by Mā yang Bzod pa rgyal mtshan in Amdo. For my argument and evidence, see chapter 4.

mathematical simplifications.[59] Although it is based upon the new concepts, terms, and methods of the *Lixiang kaocheng* such as geographical knowledge about latitude, longitude (time difference), geometric knowledge about semi-diameter of the sun and moon, parallax for solar eclipse calculation, they are not based upon theoretical understanding or real calculations of modern trigonometry. Rather, the calculational tables from the *Lixiang kaocheng* / *Lixang kaocheng houbian* (歷象考成後編)[60] were copied and used without theoretical basis, given the calculational algorithm for eclipse calculation. And while basically standing on the shoulders of giants of *skar rtsis*, Tibetan astronomers tried to assimilate the Chinese (fundamentally Western) method into the well-established *skar rtsis* tradition buttressed by the authority of the *Kālacakra* for the accuracy of eclipse calculation. In other words, *skar rtsis* based upon the *Kālacakra* is the only dominant and superior system through which Tibetan astronomers could interpret other traditions. Still, bilateral affirmation of *skar rtsis* and *rgya rtsis* is found in Tibetan *rtsis* literature along with the paradox, which does affirm the difference and even the contradiction has formed and shaped the current Tibetan astronomy.

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[59] This means that it is not a Tibetan development from the *Rgya rtsis chen mo*. Because the *Lixiang kaocheng* — for the information on this astronomical text, see below note 325. — is the continuation of the *Xiyang xinfa lishu* of Qing China astronomy, the mathematics that the *Rgya rtsis chen mo* and *Mā yang rgya rtsis* are based upon are basically the same. Of course, there are slight corrections and adjustments in the *Mā yang rgya rtsis.* However, this does not mean that the *Mā yang rgya rtsis* developed from the *Rgya rtsis chen mo.* Straightforwardly, the *Mā yang rgya rtsis* is not an offspring of the *Rgya rtsis chen mo*.

[60] For the information on the *Lixang kaocheng houbian*, see also below note 325.

ARGUMENT

Throughout these chapters, I raise the issue of the paradox that the *skar rtsis* approaches and methods may evince. In chapters 1 and 2, I explain how Tibetan astronomers make sense of *bstan rtsis* and *gso sbyong* in conjunction with an eclipse. In chapter 1, I discuss concerns regarding the conflicts between the *Kālacakra* and the Buddhist texts that are incompatible with the *Kālacakra,* in terms of *bstan rtsis*, and in chapter 2, I discern the fact that the *zhag mi thub* is incompatible with the *yul bstun gso sbyong*. In this work, I point out that Tibetan astronomers selectively chose possible grounds for justifying the relationship between Buddhism and astronomy, but thereby brought about the affirmation of contesting two or more concepts, texts, traditions, etc. It is a paradox of affirmation in a Deleuzian sense. In chapter 3, I tackle discussing the ways in which different knowledge sources are melted for an explanation of astronomical phenomena in general and for eclipse calculation in particular. The *dgongs pa* (S. *abhiprāya.* intention) was applied to the knowledge sources within the boundary of the *Kālacakra/skar rtsis*. The limited information in the *Kālacakra* and *skar rtsis* texts is not a defect, but meant that they require further explanation (= *dgongs pa can*). Also, the limitation of the *Kālacakra* essentially left a certain scope for non-*Kālacakra* sources. Confronting such a situation, Tibetan astronomers affirmed both the *Kālacakra* and non-*Kālacakra* sources for the explanation of astronomical phenomena, including eclipses. Interpretation of all the knowledge sources was attempted in a compatible way under the roof of the *Kālacakra*. It is again a paradox of affirmation. In particular, the two different systems, *skar rtsis* and *rgya rtsis*, were believed to be compatible (T. *mthun pa*). Tibetan astronomers affirmed both sides without probing the essential differences, in terms of theory and mathematics. The belief that both can be reconciled brought about the creation of the unique *Mā yang rgya rtsis*, which adjusted the *rtsis 'phro* values of the *skar rtsis* to those of *rgya rtsis*, which will be described in chapter 4 by showing the mathematical methods. Most of all, all the approaches and methods taken by Tibetan astronomers boil down to the fact that they were able to figure out the discrepancy, seemingly logical conflicts and contradictions, etc., by being centered upon the supreme and ultimate *Kālacakra*.

I indicated in the above that I use the term "paradox" in a Deleuzian sense. Therefore, in what sense does Deleuze use the term? He uses the concept of "series" ("séries") to explain two or more different concepts that are not irrelevant to and are not reduced to each other.[61] He presents the three conditions of the "serialization" ("la mise en séries") as "1) There must be at least two heterogeneous series, one of which shall be determined as "signifying" and the other as signified (a single series never suffices to form a structure). 2) Each of these series is constituted by terms which exist only through the relations they maintain with one another. ... 3) The two heterogeneous series

[61] Explanations on the meaning of "series" in Deleuze (1973) are found in many works of modern research. Because this writing does not aim at commentating on the concept, let me be restricted to introducing the following work: Poxon and Stivale (2011: especially, 70-2). Deleuze's basic idea is that events, things, etc. have no "sense" (meaning) *per se*, and their "sense" is generated by "serialization," when being included in a "series" and thereby being related to other events, things, etc, in a differerent "series."

converge toward a paradoxical element, which is their differentiator."[62] His unique terms and concepts are understood this way: one "series" is superior to the other. So, the two "series" continue to be in a nonequilibrium state and dispersion. The terms of each "series" are in continuous deplacement and shift with respect to other "series". In other words, there exists an essential sliding between the "series", without being reduced to one another. The crucial concept "a paradoxical element" in his scheme is the stratum enabling a "series" to have superiority and enabling the relative deplacement of the two (or more) "series." It belongs to both and neither at the same time. It is called by him "quelconque (*aliquid*)," "fundamental blank," "lack," etc., which transforms the structure to "devenir" (becoming).

His scheme can be applied in the interpretation of the various aspects regarding the development of *skar rtsis* in Tibet. To take the relationship between the *skar rtsis* and *rgya rtsis* as an example, 1) there exist a religious "series" (*Kālacakra* and *skar rtsis*) and a non-religious "series" (*rgya rtsis*). The former is superior to the latter. 2) The disperse relation is constituted between the two "series" in terms of astronomical concepts and calculation methods, but there is no reduction to a single concept between them. 3) There exists a paradoxical element, "*aliquid*," which is a fundamental stratum, a undivided whole, or pre-existence enabling the interaction and interface between the religious and non-religious "series". This means that "a paradoxical element" in the *Kālacakra* makes possible the bifurcation of "sense ("sense," meaning.)." Ultimately,

[62] See Deleuze (1973: 70-1) [= Deleuze (1990: 50-1)].

"sensation," the generation of "sens," is in the process of the "becoming." The scheme of paradox is also applicable to the following different "series": *Kālacakra*/non-*Kālacakra* buddhist texts, *grub rtsis*/*byed rtsis*, *skar rtsis*/non-*Kālacakra* elements, such as observation, empirical evidences, etc. The astronomical "sens" is being made by the reciprocal relationships between the different "series," i.e. the "serialization" of the individual "series." The part and parcel of the paradox in the Tibetan astronomical "serialization" is that there exists an unequal "series" in making sense of different and seemingly conflicting "series." Importantly, it is the "series" of the *Kālacakra.* Its superiority is presupposed and postulated for the "sense" making.

How is the superiority of the *Kālacakra* posited? We may need a holistic perspective that regards the *Kālacakra* as a complete and self-sufficient whole. Let me use Quine's (1908–2000) holistic approach to science: because there are multiple hypotheses and theories accounting for certain phenomena, even if a hypothesis or theory looks refuted by counter-hypotheses, it can be sustained with newly added auxiliary hypotheses. Therefore, the hypothesis or theory is not disproved.[63] If his argument is applied to the *Kālacakra*, it can be assumed that counter-observations and counter-instances (from our perspective, not from Tibetans' perspective), in whatever forms, do not overturn the *Kālacakra*, which is the complete whole on which Tibetan astronomers

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[63] According to Quine (*1951: 38-9*) and Quine (1975: 313-4), scientific hypothesis or theory cannot be proved or disproved by empirical observations. In order for a theory to be verified, it should be proved that there is no other way to explain that the same phenomena would occur in a different way, but this is impossible. Because there are multiple hypotheses and theories for a phenomenon, even if a hypothesis or theory looks refuted by empirical data, it can be sustained by adding new subsidiary hypotheses. For this well-known "Duhem/ Quine thesis (paradox)," see Cuonzo (2014: 66-73).

rely. In other words, Tibetan astronomers have found solutions to make sense of the *Kālacakra* under any circumstances that are contradictory to or incompatible with its explanations because it is a holistic integrity system, the components of which reinforce and strengthen one another. Regarding this approach, Wittgenstein might have said this[64]: "In the game of the *Kālacakra* language, the meaning and use of each term is decided by the whole system of *Kālacakra.* The use of the language is circumstantial. The paradox in the *skar rtsis,* based upon the *Kālacakra,* is that multiple interpretations are possible in every case, including apparent discrepancy, seemingly conflicts, and contradictions between *rtsis* calculations and real astronomical phenomena. Being based upon the paradox, Tibetan astronomers choose a possible interpretation or explanation to make sense of the *Kālacakra* and *skar rtsis* systems."

Skar rtsis is an indigenous astronomy, which has evolved in the Tibetan soil on the basis of the Indic *Kālacakra*. In it, "paradox" is explicitly and implicitly assumed for the explanations of astronomical phenomema, including eclipse calculations. Accordingly, a

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[64] In a similar context with Quine's holistic approach to science, Wittgenstein's *(1889–1951) holistic view* of languages in use may be mentioned. Let me first cite his famous passages in Wittgenstein (1999: 81, 81e): "Unser Paradox war dies: eine Regel konnte keine Handlungsweise bestimmen, da jede Handlungsweise mit der Regel in Übereinstimmung zu bringen sei. Die Antwort war: ist jede mit der Regel in Übereinstimmung zu bringen, dann auch zum Widerspruch. Daher gäbe es hier weder Übereinstimmung noch Widerspruch." "This was our paradox: no course of action could be determined by a rule, because every course of action can be made out to be in accordance with the rule. The answer was: if everything can be made out to agree with the rule, then it can also be made out to conflict with it. So there would be neither accord nor conflict here." Here, he means the paradox that it is impossible to decide which use of language is correct. His nonessentialist approach to language is well embodied in the introduction of the concept of "language game" from a holist viewpoint; Wittgenstein (1999: 5, 5e): "Ich werde auch das Ganze: der Sprache und der Tätigkeiten, mit denen sie verwoben ist, das 'Sprachspiel' nennen." "I shall also call the whole, consisting of language and the actions into which it is woven, the "language game"" He argues that the meaning of a word is not fixed, but it varies according to the whole system of language.

crucial question for the *skar rtsis* is how it created the "sense" of "nonsense" while being centered upon the *Kālacakra*. It is another way of asking how "paradox" developed through "serialization" in the context of the *Kālacakra*." From such a standpoint, I attempt to show the fundamental features of the development of the Tibetan *Kālacakra* astronomy by using 18th century eclipse calculations.

Part I.

RELIGIOUS REASONS FOR ECLIPSE CALCULATION

CHAPTER ONE[65]

BUDDHIST CHRONOLOGY (T. *BSTAN RTSIS*)

1. BACKWARD CALCULATION (T. *YAR LOG GI RTSIS*)

THE YEAR OF THE BUDDHA'S *KĀLACAKRA* TEACHING

Buddhist chronology has been one of main concerns for modern scholars who study the history of Buddhism. In spite of their efforts to figure out the date of the Buddha, the different Buddha's dates presented by different regional traditions are frustrating in nature.[66] In the Tibetan scenery,[67] it is complicated indeed because of mass

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[65] I use date number 0. This is simply for the convenience for calculation. There is no date 0 in the actual Tibetan calendar. For example, 1785 (year)/3 (month)/0 (date) (according to *grub rtsis*) is the transition point between 1785/2/30 (= April 9, 1785) and 1785/3/1 (= April 10, 1785). The 3(*nag zla*)/0 is usually set as epoch in Tibetan calendar. The Tibetan year may span two Western years. For example, 1785/12/1 in the case of *grub rtsis* = January 1, 1786 C.E. The Tibetan year begins with the third month (*nag zla*) and ends with the second month (*dbo zla*). So, 1785/2/30 means the last day of the *dbo zla* in the wood-dragon year (*shing 'brug*. 1784-1785) during the 13th *rab byung.* Also, 1785/3/1 means the first day of the *nag zla* in the wood-snake year (*shing sbrul.* 1785-1786.) in the same *rab byung*. At this point, in order to avoid the audience's misunderstanding, I should also indicate that I use a slash to indicate unit. For example, the numbers and slashes in the parenthesis in the case of $19^{k}49^{q}48'4''56'''$ (27/60/60/6/67) mean each *gnas*'s *'khor grangs* (= *dkyil 'khor*).

[66] The articles in *The Dating of the Historical Buddha* (3 volumes) published during 1991~1997 under the leadership of H. Bechert embrace many chronological exegeses of regionally different Buddhist traditions. In spite of them, we should admit that the historic date of the Buddha is difficult to be pinpointed.

of different years suggested by individual scholars. The complexity has been revealed by some modern researches.[68]

One of the main exegeses in Buddhist chronology in Tibet is based upon the *Laghukālacakra* and *Vimalaprabhā* in which the Buddha's year of *Kālacakra* teaching is given.[69] However, they do not give a full information of the Buddha's life. Without pinpointing the Buddha's year of *Kālacakra* teaching, they merely state "after this year, 600 years," (T. *lo 'di nas ni drug brgya'i lo yis*), Mañjuśrī Yaśas will appear.[70] "This year"

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[67] As will be described below, the Tibetan chronology whose relationship to Indic one may be posited is more complex and diverse. For example, there are many different opinions even among the *Kālacakra* adherents whose exegeses are based upon *Kālacakra, Vinaya* texts, etc. For a brief understanding of Indic chronology, see Lamotte translated in Webb-Boin (1988: 13-23). I focus on Tibetan *Kālacakra* chronology.

[68] The following works are listed: Vostrikov translated in Gupta (1970: 101-37), Macdonald (1963: especially 64-71), Grönbold (1991), Seyfort Ruegg (1992), van der Kuijp (2011). However, no research has been made about the astronomical meaning of the Buddha's enlightenment during a lunar eclipse in terms of *bstan rtsis* which has been a serious issue to Tibetan astronomers.

[69] Grönbold (1994: 11) classifies the year of Buddha's *Kālacakramūlatantra* teaching into four: "there are four theories: 1) Buddha preached in the year of enlightenment, 2) one year after enlightenment, 3) one year before *nirvāṇa*, 4) in the year of *nirvāṇa*." Mkhas grub belongs to 2) and *Phug pa* scholars belong to 4). However, Grönbold (1991: 395-8) [= Grönbold (1996: 322-4)] is misleading. Grönbold (1996: 323): "1. in the year of his enlightenment, 2. one year after his enlightenment, 3. one year before his *nirvāṇa*, 4. in the year of his *nirvāṇa*. ... according to 4, the Buddha and Sucandra died in successive years." Unfortunately, his explanation excludes *Phug pa*'s opinion. According to the *Phug pa* scholars, Buddha's year of death is 881 B.C.E. and Sucandra's year of death is 878 B.C.E.

[70] For the Tibetan in the *Laghukālacakratantra*, see *Bka' 'gyur dpe bsdur ma*, vol. 77: 63 [= verse I. 26]. For a translation, see Newman (1987: 531-2), Henning (2007: 217). "600 years after" means the following: six dharma kings beginning from Sureśvara (877 B.C.E ~ 778/777 B.C.E.) reign for 600 years and Mañjuśrañjśa Śambhala king Mañjuśrañjśa (277 B.C.E ~ 178 B.C.E) appears and teaches *Laghukālacakra*. In other words, "600 years" are from 877 B.C.E. to 278 B.C.E. And then, Puṇḍarīka (177 B.C.E ~ 78/77 B.C.E.) appears and composes the *Vimalaprabhā* commentary. For the verse in the *Laghukālacakratantra*, see Toganoo (1989: 741-2), Banerjee (1959: 58-61), Newman (1987: 531-42), Henning (2007: 217-26). For the comentary on this verse in the *Vimalaprabhā*, see Toganoo (1989: 841-4), Newman (1987: 531-42), Henning (2007: 217-26).

means "the year when the Buddha taught the *Kālacakra*" according to the *Vimalaprabhā* I. 26. Together with the Buddha, Sucandra appears as an important figure in the transmission of the *Kālacakra* teaching, and the history of Śambhala appears in the verses I. 3 and I. 150-170.[71]

By making the best of the meager information, Tibetan astronomers try to figure out which year is "this year" and what time span is "600 years." Vast opinions have been presented, but the following opinions, which diverge by the difference in the interpretation of Sucandra's (977 B.C.E. ~ 878 B.C.E.) last four years, i.e., 881 B.C.E. ~ 878 B.C.E. in conjunction with the Buddha's *Kālacakra* teaching, may be regarded as those that have had far-reaching repercussions.

Table 1.

	Byed rtsis: Bu ston	*Byed rtsis*: Mkhas grub / Sum pa Mkhan po[72]	*Grub rtsis*: *Phug* system[73]
881 B.C.E. (*lcags 'brug*)			**The Buddha preached *Kālacakramūlatantra*** (*rtsa rgyud*) and then entered into the *nirvāṇa* in the month of *sa ga*/ *vaiśākha*.

71 For this information, see Newman (1987: 74-5).

72 As seen in the table, there is a one year difference between Bu ston and Mkhas grub/ Sum pa Mkhan po. Modern research has clarified the point: for the brief introduction of their *bstan rtsis*, Vostrikov (1970: 108-9), Grönbold (1991: 396) [= Grönbold (1996: 322)], Seyfort Ruegg (1992: 278-9). Thu'u bkwan III also belongs to this group; see Thu'u bkwan III translated in Geshe Lhundub Sopa (2009: 382). Unfortunately, some years are misunderstood: *chu rta sna tshogs* (*citrabhānu* = water-horse year) is 879 B.C.E., not 878 B.C.E. Thus, Sucandra's last year should be given as 878 B.C.E., not 877 B.C.E. in Thu'u bkwan III (2009: 381).

73 The textual basis is as follows: Grwa phug pa (2002: 78-92, especially 85-8), then Nor bzang rgya mtsho as translated in Kilty (2004: 29-31), and 'Phrin las dge ba'i dbang po (2002: 596-599). See also below pp. 50-1.

Table 1 (continued)

880 B.C.E. (*lcags sbrul*)	The Buddha attained enlightenment.		Sucandra wrote the *Mūlatantra* down from this year for two years.[74]
879 B.C.E. (*chu rta*)	**The Buddha preached the *Kālacakramūlatantra.***	The Buddha attained enlightenment.	
878 B.C.E. (*chu lug*)	Sucandra wrote the *Mūlatantra* down, built the *maṇḍala* and passed away.	**The Buddha preached the *Kālacakramūlatantra.*** Sucandra wrote the *Mūlatantra* down, built the *maṇḍala* and passed away.	Sucandra passed away.
"600 years"	counted from the Buddha's enlightenment (878 B.C.E.).		counted from the Buddha's *nirvāṇa* (881 B.C.E.). But, Sucandra's 3 years (880 B.C.E. ~ 878 B.C.E.) are excluded from the "600 years."[75]

The issue of how to insert the Buddha's years in a way of being compatible with Sucandra's years specified in the *Vimalaprabhā* has been a bone of contention. Both *byed rtsis* and *Phug pa grub rtsis* present the year of the Buddha's *Kālacakra* teaching respectively in the following way: *byed rtsis*: 879/878 B.C.E.; *Phug* system: 881 B.C.E. However, the main difference is that in the case of Mkhas grub and his adherent Sum pa Mkhan po's *byed rtsis*, the Buddha taught the *Kālacakramūlatantra* one year after the year of his enlightenment. Meanwhile, in the case of the *Phug* system, the year of *nirvāṇa* is the same with that of the *Kālacakra* teaching. Concerning the "600 years," both show

[74] Kilty (2004: 28): "King Sucandra compiled the *Root tantra* and composed a commentary. This would have involved one or two years." Also see Henning (2007: 367). Nor bzang rgya mtsho (2004: 612).

[75] Kilty (2004: 29): "the three years of Sucandra and the year the Buddha taught the *Root tantra* account for four years not included in the six hundred."

discrepancy: In the former, "600 years" are counted from the Buddha's enlightenment and in the latter, "600 years" are counted from the Buddha's *nirvāṇa.* The division is commonplace in Tibetan *rtsis* texts. For example, Kaḥ thog Rig 'dzin Tshe dbang nor bu (1698–1755), who did one of the most comprehensive overarching research into *bstan rtsis* during the 18th century,[76] classified the *bstan rtsis*-s based upon the *Kālacakra* system into two categories and presented 13 different interpretations. In the following table, the years counted from the Buddha's enlightenment by different scholars are given in the left cell, and the years counted from the Buddha's *nirvāṇa* in the right cell according to Kaḥ thog Rig 'dzin's research.[77] It should be noted that he presented rarely metioned astronomers, thus filling in the blank in the intellectual history.

Table 2.

Elapsed years from the year of the Buddha's *nirvāṇa*. (In this case, Buddha taught the *Kālacakra* after his enlightenment).	Elapsed years from the year of the Buddha's *nirvāṇa*. (In this case, the Buddha taught the *Kālacakra* prior to his *nirvāṇa*).

[76] See Kaḥ thog Rig 'dzin (1976-1977: 111-5) [= (2006: 40-1)].

[77] The two groups of *'das lo* calculated from 1742 C.E. are presented. For the year 1742 C.E., see Kaḥ thog Rig 'dzin (1976-1977: 115) [= (2006: 41)]. For the same kind of division, read also Tshe tan zhabs drung (2007: 10-4): He classifies *dus 'khor ba* into two, *'das lo mang ba'i phyogs* including three *rgya mtsho*s in the *Phug* system (Gtsang chung Chos grags rgya mtsho, Phug pa Lhun grub rgya mtsho, Mkhas grub Nor bzang rgya mtsho), etc. and *'das lo nyung ba'i phyogs* including Bu ston, Mkhas grub, etc. Also, see Tshe tan Zhabs drung (2007: 27): *Phug pa* scholars' *shing rta* and Tshe tan Zhabs drung (2007: 30): Mkhas grub's *chu rta* for the year of the Buddha's enlightenment. See also Seyfort Ruegg (1992: 278, especially no. 73).

Table 2 (continued)

3049: ’Gos Lo tsā ba. 1742 – (3049 + 1) = 1308 B.C.E. (= the year of the Buddha’s *nirvāṇa*) **2575**: Dol po pa, Bu ston, Bo dong Phyogs las mam rgyal, Mnga’ ris Chos rje, Rtogs ldan (Mnga’ ris Chos rje’s disciple), Sgra pa Nam mkha’ bzang po, ’Jam dbyangs Chos kyi mgon po, Gnyag phu Bsod nams bzang po, Mtshur phu ’Jam dbyangs che ba, Thil pa kun rgyal, Paṇ chen Byams pa gling pa[78], Byang bdag, Rgya phrug Dkon mchog rin chen (who ?), Mkhas grub, Chos skyong bzang po, Rig ’dzin Blo gros rgyal mtshan, etc.. 1742 – (2575 + 1) = 834 B.C.E.	2799: ’Brug pa Phu (*sic.*) re sha ma ti.[79] 1742 – (2799 + 1) = 1058 B.C.E. **2622**: *Phug lugs*/ Kong po ’Bum rams pa.[80] 1742 – (2622 + 1) = 881 B.C.E. 2619: G.yung ston Badzra shrī.[81] 1742 – (2619 + 1) = 878 B.C.E. 2617: Dwags po Paṇḍita.[82] 1742 – (2617 + 1) = 876 B.C.E. 2435: Karma pa III. 1742 – (2435 + 1) = 694 B.C.E. 2368: Chag Lo Gsum pa Rin chen chos rgyal (1447-?). 1742 – (2368 + 1) = 627 B.C.E. 2315: Sa skya’i bla ma dam pa’i dgongs pa. 1742 – (2315 + 1) = 574 B.C.E.

[78] His name Bsod nams rnam rgyal (1401–1475). See Martin (1997: 63). Dharmaśrī (1999a: 150b) briefly quotes some phrases in a text written by him. Unfortunately, Dharmaśrī did not specify the title.

[79] Lha dbang blo gros’s (S. Sureśamatibhadra) *Bstan rtsis ’dod sbyin gter bum* was studied by Schlagintweit (1897). Kaḥ thog Rig ’dzin (2006: 40) addresses “*gdan dus kyi rtsis gzhi mkhan po*” before his name. For the tradition, *gdan dus* (occasionally appears as *gdan du*) in Bhutan, see Martin (1997: 95-6).

[80] For this unidentified *rtsis pa*, see Dharmaśrī (1999a: 150b): “the writings of ’Phrin las pa’s direct disciples such as the documents of Kong po ’Bum rams pa, etc.” (*kong po ’bum rams pa’i yig cha sogs phrin* (*sic.*) *las pa’i dngos slob rnams kyi yi ge ...* .). But we do not know the identity of (Chos rje) ’Phrin las pa. He is introduced as the author of *’Khrul med mdzub tshugs* (Dharmaśrī (1999a: 149b). According to van der Kuijp, it is highly probable that he is Karma ’Phrin las pa (1456–1539) who wrote a commentary on Karma pa III’s *Kālacakra* text, which has been mentioned in Dpa’ bo (n.d. (1): 293a).

[81] He has been mentioned by many scholars. See Schlagintweit (1897: 630), Macdonald (1963: 68), Seyfort Ruegg (1992: 276, 278).

[82] He seems to be Karma ’Phrin las pa. See above note 80.

Table 2 (continued)

2392: Grub thob O rgyan pa Rin chen dpal 1742 – (2392 + 1) = 651 B.C.E. 2374: Jo nang Tāranātha 1742 – (2374 + 1) = 633 B.C.E.	2216: Rong pa Ngag dbang grags pa.[83] 1742 – (2216 + 1) = 475 B.C.E. 2115: Zhwa dmar pa II Mkha' spyod dbang po (1350–1405) 1742 – (2115 + 1) = 374 B.C.E.

As seen from above, there are many possible years even in the separate two categories. Let me focus on the two interpretations: 1) in the case of 2575 elapsed years (*'das lo*) in the left cell, the year of *nirvāṇa* is 834 B.C.E. As previously seen, the year of the Buddha's *Kālacakra* teaching is either in or one year after the year of enlightenment, i.e., 879 B.C.E. or 878 B.C.E. according to *byed rtsis*. 2) in the case of 2622 elapsed years in the right cell, the year of the Buddha's *nirvāṇa* is 881 B.C.E. This is also the year of the Buddha's *Kālacakra* teaching. Then, why *byed rtsis* scholars, who belong to the first category [= 2575 elapsed years in this case = *'das lo nyung ba'i phyogs* according to Tshe tan Zhabs drung (2007)], and *Phug pa* scholars, who belong to the second [= 2622 elapsed years in this case = *'das lo mang ba'i phyogs* according to Tshe tan Zhabs drung (2007)], suggest the Buddha's years differently? What are their rationale?

THE BUDDHA'S ENLIGHTENMENT AND THE LUNAR ECLIPSE: *YAR LOG GI RTSIS*

[83] Rong pa Ngag dbang grags pa is unidenfied, but his tradition has been mentioned briefly in Bsod nams rin chen (2009: vol. 2, 188): "If 406 is subtracted [from the *Phug* tradition], [it is] the tradition of Rong pa Ngag dbang grags pa." (*... bzhi brgya dang drug phri na rong pa ngag dbang grags pa'i lugs so /*). This is also verified in the above table: 2622 — 2216 = 406. The difference of *'das lo* between him and the *Phug* tradition is 406 years.

As seen above, the Buddha's year of the *Kālacakra* teaching and Sucandra's year of writing a commentary to it are specified in the *Vimalaprabhā*, but the information such as the year of the Buddha's birth, life span, etc., is not specified. Under such situation, Tibetan *Kālacakra* proponents selectively chose some Buddhist texts to compensate for the meager chronological information. In doing so, they paid attention to and made sense of the Buddha's enlightenment during a lunar eclipse recorded in such Buddhist texts as the *Vinaya sūtra*, the *Abhiniṣkramaṇa sūtra,* the *Lalitavistara sūtra*, etc.:[84] Their strategy was

[84] A modern calculation based upon *Saṃyutta nikāya* stating that the luar and solar eclipses occurred during Buddha's stay at Śrāvastī has been made by Sengupta (1956: 124-8), Sengupta (1947: 217-21). Basically, his line of thinking is the same as that of the Tibetan astronomers. Also read Hartmann's summary and criticism made from the phililogist's viewpoint in Hartmann (1991: 35-6). The Tibetan logic based upon reconcilation between *Kālacakra* and some Buddhist *sūtra*s is seen *passim*. To take some examples: Nor bzang rgya mtsho as translated in Kilty (2004: 30-1). Lha dbang blo gros (200?: 263-5). For German translation, see Schlagintweit (1897: 600-1). However, it is easily known that, if we broaden our vision to the other texts *Phug pa* scholars do not use, there is collision among different canons in terms of *bstan rtsis*. The following counterarguments have been raised sporadically by Tibetan scholars. For example, Paṇ chen Bde legs nyi ma's (16^{th} c.) explanation of *dus chen* finds this quotation. Bde legs nyi ma (2011: 143): "According to the *Kālacakra* tradition, [the Buddha] attained enlightenment at the age of 37, on the full moon day of the month of *sa ga* in water-male-horse year (879 B.C.E.). [According to] the Vinaya tradition, [the Buddha attained] enlightenment at the age of 35, on the full moon day of the month of *sa ga* in iron-male-dragon year (881 B.C.E.)... ." (*dus 'khor ba'i lugs la lo sum cu rtsa bdun pa chu pho rta'i lo sa ga'i nya la mngon par byang chub / 'dul ba'i lugs dgung lo sum cu rtsa lnga pa lcags pho 'brug gi sa ga zla ba'i nya la mngon par byang chub pa yin te / ... .*). In the first case, the *Kālacakra* proponents (*dus 'khor ba*) include Mnga' ris Chos rje, Mkhas grub, etc. (according to them, 915 B.C.E. is the year of the Buddha's birth. $915 - 879 = 36$. $36 + 1 = 37 =$ the Buddha's age). Bde legs nyi ma claims that it does not accord with the Vinaya tradition stating that the Buddha attained enlightenment in 881 B.C.E.. The claim may be based upon Bde legs nyi ma's real calculation based upon the records of the lunar eclipse at the Buddha's enlightenment in Vinaya, although he did not metion it. To take another example, Kaḥ thog Rig 'dzin's calculation asserts that in the case of *Lalitavistara sūtra*, the Buddha's enlightenement is placed in 881 B.C.E. (*lcags 'brug*). Kaḥ thog Rig 'dzin (1976-1977: 118-22) [= Kaḥ thog Rig 'dzin (2006: 43-4)]: "In the *Lalitavistara sūtra* ... [the Buddha] attained enlightenment at the age of 35, on the full moon day of the month of *sa ga* in the iron-dragon year (881 B.C.E.) called *vikrama* (*dpa' bo*). ... Furthermore, in the *dhru ba* (root quantity) of this *sa ga* month: *gza' dhru* 3/30/54 [= $3^{z}30^{q}54'$ in my notation], *ril bo/ cha shas* 20/34, *nyi dhru* 1/16/33 [= $1^{k}16^{q}33'$], on the 15^{th} day: *gza' dag* 4/50 [= $4^{z}50^{q}$], *nyi dag* 2/31 [= $2^{k}31^{q}$], *tshes 'khyud zla skar* 16/1 [= $16^{k}1^{q}$], *res 'grogs zla skar* 15/11 [= $15^{k}11^{q}$], *sgra gcan rtsa* 23/18 [= $23^{k}18^{q}$], *sgra gcan gdong* 3/41 [= $3^{k}41^{q}$], *dus me* (= *sgra gcan mjug*) 17/11 [= $17^{k}11^{q}$]. Because 0/38 [= $0^{k}38^{q}$], the remainder of the subtraction, arises according to *man ngag* (S. *upadeśa*), $\frac{1}{4}$ is eclipsed according to *myong rtsis* (calculation based on empirical data). Moreover, [ ] need to know the

opinions that [the Buddha] attained the enlightenment on the eighth day of the month of *sa ga* in accordance with the *Mahāparinirvāṇa sūtra*, *Bka' brgyad rdzong 'phrang* of Tibetan ancient mantra, and Chinese monk (> Ch. *heshang* 和尚) *Chan* (禪) masters (T. *bsam gtan mkhan* (*po*) *rnams*), and the assertion made by mother tantra proponents such as Indian master Dārika and others that [the Buddha] attained the enlightenment on the tenth day of the waning moon. ... Moreover, it is stated in the chapter of Empowerment (S. *Abhiṣekapaṭala*/ T. *Dbang le'u*. Chapter III) in the *Vimalaprabhā* that, here in the holy land, Bhagavān Śākyamuni attained the enlightenment at the time of the rise of dawn on the full moon day of the month of *sa ga*, [at the moment of] entering into the first day of the *kṛṣṇapakṣa*, at the end of the 15 parts (*cha*. here means *tshes zhag*) such as the first day (*tshes zhag*), etc. [= from the first day to the fifteenth day] of the *śuklapakṣa* and [it is] also written in some other texts such as the particular *sngags gzhung*." (*... mdo rgya che rol pa nas ... dgung lo sum cu rtsa lnga bzhes pa dpa' bo zhes lcags 'brug sa ga'i nya la byang chub shing ... de yang sa ga zla ba 'di yi dhru bar gza' gnas gsum chu tshod sum cu / srang nga bzhi / ril bor nyi shu cha shas so bzhi / nyi dhrur skar gnas gcig / chu tshod bcu drug / chu srang so gsum / de yi tshes bco lnga'i gza' dag gza' gnas la bzhi / chu tshod lnga bcu / nyi dag skar mar gnyis / dbyu gur so gcig / tshes 'khyud skar mar bcu drug / dbyu gur gcig / res 'grogs skar mar bco lnga / dbyu gur bcu gcig / sgra gcan bul bar skar gnas nyer gsum chu tshod bco brgyad / gdong skar gsum / chu tshod zhe gcig / dus me'i skar mar bcu bdun / chu tshod bcu gcig ste man ngag bzhin sbyangs dor gyi lhag skar gnas thig dang chu tshod so brgyad shar bas myong rtsis ltar bzhi cha gcig 'dzin pa yin no / gzhan mdo sde mya ngan 'das pa chen po dang / bod sngags rnying pa'i bka' brgyad rdzong 'phrang dang rgya nag hā shang bsam gtan mkhan rnams mthun par sa ga zla ba'i tshes brgyad la sangs rgyas par bzhed pa dang / rgya dkar gyi slob dpon dā ri ka sogs ma rgyud smra ba pos ni mar ngo'i tshes bcur sangs rgyas par 'dod pa dag kyang shes par bya dgos la / ... / de yang dri med 'od kyi dbang le'u yi skabs su / 'phags pa'i yul 'dir dkar po'i tshes gcig la sogs pa cha bco lnga'i mthar nag po'i tshes gcig 'jug pa sa ga nya'i skya rengs 'char ba'i tshe bcom ldan 'das shākya thub pa mngon par rdzogs par sangs rgyas te zhes dang / sngags gzhung khyad par can gzhan nas kyang 'byung ltar ro /* .). Explanations on some terms are necessary for the understanding of the above quotation: About the term *dpa' bo* (S. *vikrama*), see Newman (1998: 344), my Appdendix I. About *bka' brgyad rdzong 'phrang*, Martin's rendering is as follows: "'breach of the citadel'; a class of *sems sde* teachings; *bon* tradition maintains a parallel group of teachings by the same name; described in tibetan as *rgya bod mkhas pa mi bzhi'i dgongs nyams gcig tu dril pa bka' brgyad rdzong 'phrang du grags pa*." (http://www.tbrc.org/#!rid=T003JR4759). As Kaḥ thog Rig 'dzin clearly shows, with vue étendue in the above passage, if we broaden our vision, we may encounter different Buddhist texts, which specify different Buddha chronologies. For example, as is scribed as an interlinear note in Mgon po skyabs's (active in 18th c. For his life, see the most updated research, Feng (2013: 8-15)) *Rgya nag chos 'byung*, *Vinaya sūtra* conflicts with *Mahāparinirvāṇa sūtra* in terms of *bstan rtsis*. See Gömbuǰab (T. Mgon po skyabs) (2005: 223). For the Chinese translation, see Blo bzang bstan 'dzin (2005: 43-4): "[Buddha] attained the enlightenment at the age of thirty, on the eighth day of the second month, finally after six year asceticism. (interlinear note: *Kālacakra* proponents assert that [the Buddha] attained enlightenment on the full moon day of the fourth month, in terms of the lunar eclipse appeared in the world as a sign of external interdependence, but, in the chapter of the Lion's Roar (**Siṃhanāda*) in the *Mahāparinirvāṇa sūtra*, there exists an explanation of the question and answer as to why the impeccable *nirvāṇa* alone is related to the 15th day of Bhagavān's birth, getting ordained, attaining enlightenment, and turning wheel of dharma fall on only the eighth day of the *śuklapakṣa*)." (*... lo drug dka' ba spyad mthar dgung lo sum cu'i thog zla ba gnyis pa'i tshes brgyad la mngon par rdzogs par sangs rgyas te* (interlinear note: *phyi'i rten 'brel gyi rtags su nyi zla 'dzin tshul 'jig rten du snang ba'i dbang du byas te dus 'khor ba rnams kyis bzhi pa'i nya la sangs rgyas par 'dod kyang / mdo myang 'das kyi seng ge sgra'i le'u las / bcom ldan 'das kyi sku bltams pa dang / mngon par 'byung ba dang / mngon par rdzogs par sangs rgyas pa dang / chos kyi 'khor lo bskor ba rnams yar tshes brgyad kho nar lags na / ci'i phyir zag med mya ngan las 'das pa'i tshul gcig bu tshes bco lnga dang sbyar zhes pa'i dri tshig lan dang bcas pa bshad pa yod do/*). For the Tibetan text of the *Mahāparinirvāṇa sūtra*, see *Bka' 'gyur dpe bsdur ma* (TBRC accession number W1PD96682), Vol. 53: *Mya ngan las 'das pa'i mdo*, 335ff. For the Chinese text of *Mahāparinirvāṇa sūtra*, see *Taisho Tripiṭaka* (*Taishō shinshū daizōkyō* 大正新脩大藏經), vol. T12, No. 374: *Daban niepan jing* (大般涅槃経), chapter 30 *Shizihou pusa pin* (獅子吼菩薩品). The electronic version is found in CBETA (www.cbeta.org), T12n0374_p0545a21(10) ff. English translation is found in Yamamoto (1973: 430). Taken to calculate values reconciling the record of the lunar eclipse at the Buddha's enlightenment in the aforementioned Buddhist texts with the year of the Buddha's *Kālacakra* teaching in the *Kālacakratantra*. More in-depth research is needed about when such line of thinking was formed first, but it seems to date back to Mnga' ris Chos rje at the latest.[85] If his student Rtogs ldan's writing is based upon Mnga' ris Chos rje's teaching, it is verified that Mnga' ris Chos rje used the aforementioned Buddhist texts in a way of being compatible with the *Kālacakra*.

> *gzhan yang 'dul ba bzhi'i (sic. read gzhi) bam po gya lnga pa las / bcom ldan 'das kyis bla na med pa'i ye shes brnyes pa na / grags 'dzin ma la khye'u zhig btsas so / zla ba yang sgra gcan gyis zin to / zhes pa dang / grags 'dzin ma'i bu ming 'dogs par byed de / btsun mo'i 'khor gyis smras pa 'di btsas pa na zla ba yang sgra gcan gyis zin pas de bas na khye'u 'di la yang sgra gcan zin zhes gdags so zhes dang / mngon par 'byung ba'i mdo las / de nas rgyal po zas gtsang la rang gi skyes bu rnams kyis smras pa / lha dgyes par mdzad du gsol / gzhon nu bla na med pa'i ye shes brnyes so / de thob pa dang nyi ma de nyid la grags 'dzin ma la yang khye'u zhig btsas so / bdud rtsi zas la yang khye'u zhig btsas so / de nyid kyi mtshan mo zla ba yang sgra gcan gyis zin to / zhes pa dang / grags 'dzin ma'i bu'i ming 'dogs par byed de btsun mo'i 'khor gyis smras pa / 'di btsas pa na zla ba yang sgra gcan gyis zin pas / de bas na khye'u sgra gcan zin zhes btags so / zhes gsungs ... .*[86]

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together, under such situation that other texts presenting Buddhist chronology exist, the reason why *Kālacakra* adherents use *Vinaya* texts, *Lalitavistara sūtra,* etc. to support their *bstan rtsis* is not known. It is possibly related to the records of the lunar eclipse at the Buddha's enlightenment in them. In other words, their astronomical concerns may have had an influence on the decision of the textual bases.

[85] For Mnga' ris Chos rje's idea, See Kilty (2004: 34). In the case of Bu ston, I did not find textual evidence that he calculated the values of the lunar eclipse at the Buddha's enlightenment. Byang bdag (3) (n.d.: 2b-3a) indicates that Bla ma dam pa Bsod nams rgyal mtshan (1312-1375) uses the *Abhiniṣkramaṇa sūtra* and the *Vinaya sūtra* to date the Buddha's life, but does not indicate whether he tried to reconcile between the *Kālacakra* calculations with these texts. I speculate that since he is contemporary with Mnga' ris Chos rje, there may have been discussions on the issue of *bstan rtsis* and its textual bases among scholars in the 14th century.

[86] Rtogs ldan (2010: 352-3). See also Nor bzang rgya mtsho (2004: 31-2).

> Furthermore, section 85 of the *Vinayavastu* (*'Dul ba gzhi*) states,[87] "When the Bhagavān obtained unsurpassable wisdom, Yaśodharā (Śākyamuni's wife) gave birth to a baby. The moon was also held by Rāhu." And "[ ] gives Yaśodharā's son a name, the retinue of the queen said, 'because when [you] gave a birth, the moon was held by Rāhu, therefore, this baby will be also called Rāhula.'" And the *Abhiniṣkramaṇa sūtra* states,[88] "After that, his people said to king Śuddhodana (Buddha's father), 'Please delight gods! The youth obtained the unsurpassable wisdom. On the very day, Yaśodharā also gave birth to a baby. A baby was also born to Amṛtodana (the uncle of Śākyamuni). In the evening, the moon was held by Rāhu.'" And "[ ] gives Yaśodharā's son a name and the retinue of the queen said, 'because when [you] gave a birth, the moon was held by Rāhu, therefore, this baby was given the name Rāhula. '"

Since the above passage appeared for the first time possibly by Mnga' ris Chos rje, it has been an all-time conundrum for Tibetan astronomers. They thought that they should accurately calculate the values of the lunar eclipse in accordance with the aforementioned Buddhist texts while reconciling with the *Kālacakra*. One of possible solutions was also given by Rtogs ldan (possibly Mnga' ris Chos rje also) arguing that the lunar eclipse at the Buddha's enlightenment occurred in 879 B.C.E.

> *bcom ldan 'das mngon par rdzogs par sangs rgyas pa'i dus kyi nyin zhag de la zla ba gzas zin pa yin la / de yang zla bzangs (sic.* read *bzang) kyi lo gcig po de zur du bgrangs pa dang bcas pa la rtsis 'phro btsal nas brtsis pa'i sa ris las gza' 'dzin 'char bar tshad mas grub cing / lo de lo drug brgya po'i nang du 'dus par byas nas zur du ma bgrangs na de dus kyi byed rtsis la gza' 'dzin mi 'char zhing / yang rgyud gsungs pa'i lo dang / lo drug brgya po'i bar du lo gnyis bcug nas brtsis pa la yang byed rtsis la gza' 'dzin mi 'char ba'i skyon yod pas lung dang mi mthun no / de nas zla bzangs (sic.* read *bzang) kyi (sic.* read *kyis) dkyil 'khor bzhengs pa sogs mdzad pa'i lo gcig pu de nyid logs su bgrangs par shin tu rigs so /*[89]

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[87] For the location of the passage in *D. Bka' 'gyur*, see Kilty (2004: 619, no. 29).

[88] For the location of the passage in *D. Bka' 'gyur*, see Kilty (2004: 619, no. 30).

[89] Rtogs ldan (2010: 353).

On the day, when the Bhagavān attained full enlightenment, the moon was held by Rāhu[90] and furthermore, the occurrence of the eclipse is established by *tshad ma*[91] from the arithmetic carried out after having sought the *rtsis 'phro* in that which counts Sucandra's one year (878 B.C.E.) separately, and if that year is not counted additionally after having included it under 600 years, the eclipse does not occur at that time in the case of *byed rtsis*, and also because the error that an eclipse does not occur exists in the case of *byed rtsis* in the calculation made after having inserted two years [from] the year of *Kālacakra* teaching up to 600 years, [it] does not accord with the texts. It is very reasonable to count the one year (878 B.C.E.) in which Sucandra built the *maṇḍala*, etc. separately.

Rtogs ldan (possibly Mnga' ris Chos rje also), possibly being based upon his calcualtions, argued that if only 878 B.C.E. is additionally calculated and is not included in the "600

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[90] The *gza'* here is Sgra gcan. In general, the Tibetan planetary system is composed of the 10 planets, one of which Sgra gcan. For example, see the terminological dictionary of the Tibetan ten sciences, *Dag yig mkhas pa'i byung gnas* [= *Merged γarqu-yin oron*] (1742): Lcang skya III et al. (1982: 49), Lcang skya III et al. (2002: 1169-70). However, it should be noted here that there exist multiple systems. See Bsam 'grub rgya mtsho (2011: 95). For example, Ishihama and Fukuda (1989: 161-2) shows a system composed of nine planets in [ML] (S. *Mahāvyutpatti* / T. *Bye brag tu rtogs par byed pa* / M. *Ilγal-i ilete uqaγulun üiledügči-yin ǰerge delgeregülün sudur*. Manuscript no. 25147 in the library of the Oriental department of the St. Petersburg State University) and [MT] (included in *Danǰuur. "Mongγol γanǰuur danǰuur-un γarcaγ"*-un nayiraγulqu ǰöblel (2002: 783-4). No. 4891 numbered from *Γanǰuur*: *Ilγal-i onuγuluγči*): *gza' dgu'i ming* [ML] *yisün graγ-un ner-e* [MT] *yisün graγ-un ner-e*. Also see Sárközi and Szerb (1995: 235). The following table is created on the basis of Lcang skya III et al. (1982), Lcang skya III et al. (2002) and Ishihama and Fukuda (1989).

Lcang skya III et al. (1982), Lcang skya III et al. (2002) (10 planets)		Ishihama and Fukuda (1989) (9 planets)
T.	M. (S.)	Mong.
Nyi ma	Naran (Āditya)	[ML] Naran [MT] Adiy-a
Zla ba	Saran (Soma)	[ML] Saran [MT] Somay-a (Somiy-a)
Mig dmar	Angγrana (Aṅgāraka)	[ML] Anggrak [MT] Anggrak
Lhag pa	Budi (Budha)	[ML] Bud [MT] Bud
Phur bu	Barqasbadi (Bṛhaspati)	[ML] Briqasbati [MT] Brqasbati
Pa sangs	Šugir-a (Śukra)	[ML] Śukra [MT] Sukra
Spen pa	Saničar (Śanaiścara)	[ML] Saniscar [MT] Sanicar
Sgra gcan	Raqu (Rāhu)	[ML] Raqu [MT] Raqu
Sgra gcan gdong	Raqu-yin terigün	
Sgra gcan mjug	Raqu-yin segül	
Mjug ma	Segül (Ketu)	T. Mjug rings [ML] Ketu [MT] Urtu segül-tü

[91] *mngon sum gyi tshad ma*. See below note 126.

years," the lunar eclipse occurred in 879 B.C.E. during the Buddha's enlightement according to *byed rtsis*.[92] The Tibetan rational presented in the above passage is called *yar log gi rtsis* (backward calculation). The key idea of the concept is as follows: If a calculational system is accuratet, it must accurately calculate the time of the lunar eclipse at the Buddha's enlightenment as described in the aforementioned Buddhist texts by means of the *Kālacakra* calculation methods.

After having been publicized, the idea of the *yar log gi rtsis* has been regarded by Tibetan astronomers as a *sine qua non* for an astronomical system to be accurate.[93]

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[92] His argument that the Buddha's enlightenment occurs in 879 B.C.E. is verified by Mnga' ris Chos rje (2008: 11). Rtogs ldan (2010: 354): "2255 years have passed since the *Mūlatantra* was preached up to now (*me mo sbrul*: 1377 C.E.) and 753 years have passed since *mleccha* invaded, and 571 years have passed since Kalkī Aja clarified *nyung ngu'i byed pa* (smaller *karaṇa*)." (*rtsa rgyud gsungs nas da lta'i bar la lo nyis stong nyis brgya lnga bcu rtsa lnga 'das shing / kla klo zhugs nas bdun brgya dang nga gsum / rigs ldan rgyal dkas nyung ngu'i byed pa gsal bar mdzad nas lnga brgya don gcig song ba yin no /*). 1377 – (2255 + 1) = 879 B.C.E. 1377 – 753 = 624 C.E. 806 C.E. + 571 = 1377 C.E. *Nyung ngu'i byed pa* is called as such because its *rtag longs* values are smaller than those of *grub rtsis*. For the values, see below pp. 195-6. And the values by Mnga' ris Chos rje is given by Lha dbang blo gros. See Schlagintweit (1897: 630) [= Lha dbang blo gros (n.d.: 305)]: *gza'*: $1^{z}37^{q}$, *zla skar*: $14^{k}21^{q}$, *sgra gcan mjug* (*dus me*): $14^{k}15^{q}$. An eclipse is possible, given the distance between *zla skar* and *sgra gcan mjug*. For more accurate values, see Sum pa Mkhan po's calculations included in the *Dpag bsam ljon bzang*: table 1 *byed rtsis* at 879 B.C.E. (*chu rta*)/4/15; see below pp. 59-60.

[93] To take some examples to trace how the idea of *yar log gi rtsis* was accepted in the earlier period (before around 16th c.): Byang bdag (3) (n.d.): throughout the text, he exmaines the accuracy of individual scholars' systems by *gyen log gi rtsis* [= *yar log gi rtsis*]. For example, Byang bdag (3) (n.d.: 5b-7a) is critical of the *byed rtsis* systems of Bu ston and Mnga' ris Chos rje, who are main concerns, in the following reasons: According to Bu ston's year counting, Byang bdag (3) (n.d.: 6a): "It would be the case that the Buddha was born in *viśvāvasu* the wood-snake year (916 B.C.E.) and if so, [ ] does not agree with the calculation results, ...". (*thub dbang sna tshogs dbyig zhes pa shing sbrul la bltams par 'gyur la / de ltar na brtsis 'bras dang mi mthun te / ... .*) But, it is generally known that Bu ston presents the Buddha's year of birth as *me rta* (915 B.C.E). See below p. 53. Byang bdag (3) (n.d.: 6b): "Because it should be said that the Buddha was born in the lunar mansion (*skar ma*. *rgyu skar*) *skag* (S. *aśleṣā*) or *mchu* (S. *maghā*), but contradicts [Bu ston's] statement that [the Buddha] was born in the lunar mansion *rgyal* (S. *puṣya*), this (Bu ston's) teaching is also unacceptable" (*thub dbang skar ma skag gam mchu la bltams par bzhed dgos na'ang skar ma rgyal la bltams par gsungs pa dang 'gal bas lung 'di yang 'thad pa ma yin no / .*). In the case of Mnga' ris Chos rje, Byang bdag (3) (n.d.: 7a): " ... because the values [showing] that the moon was eaten by the Rāhu when the Buddha attained the enlightenment do not arise, this tradition is not true." (*... mngon par rdzogs par sangs rgyas pa'i dus / zla ba gzas bzung ba'i ri mo yang mi 'char bas lugs 'di yang dag pa ma yin no / .*) Lha dbang blo gros (16th century 'Brug pa bka' brgyud pa) is also

Astronomers such as Grwa phug pa, Nor bzang rgya mtsho, etc. of the *Phug* system, whose system has been used extensively in Tibet since the 15th century, also presented their ideas according to the logic. They reconciled the same texts, i.e., *Vinaya sūtra*, *Abhiniṣkramaṇa sūtra, Lalitavistara sūtra*, etc. with their calculations. For example, their values for the lunar eclipse at the Buddha's enlightenment are given in Grwa phug pa's *Pad dkar zhal lung* in this way.[94]

> *... rgyal ba zhes pa shing pho rta la mngon par rdzogs par sangs rgyas pa yin no / ... / ... rgya cher rol pa las / skar ma sa ga la bab pa na mngon par rdzogs par sangs rgyas par gsungs pa ni gong du bshad pa'i rigs pa ltar zla ba'i nya dang sbyar ba'i skar ma tsam la dgongs pa yin gyi / zhib mor byas nas 'tshang rgya bzhin pa'i dus kyi skar ma ni lha mtshams dang / tshes kyang bcu drug pa*

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dominantly under the influence of the idea, as seen in Schlagintweit (1897). Throughout his writing, he calculates and presents the figures of *lnga bsdus*, *sgra gcan*, etc. of some *bstan rtsis* traditions to check the possibility of the lunar eclipse at the Buddha's enlightenment given by each system. In conjunction with it, Singh (1991: 124-5): "various scholars (14 scholars) determined the year of the birth of the Buddha according to their own viewpoints. It is, however, accepted by all of them that there was a moon eclipse according to the *Vinayāgama sūtra* at the time of the full-moon day of *vaiśākha* when the Buddha was born." This is not correct: We have no textual bases to prove that all of them tried to accommodate the *Vinaya* to prove the occurrence of the lunar eclipse at the Buddha's enlightenement. Most of all, the lunar eclipse occurred not at the Buddha's birth but at the Buddha's enlightenment.

[94] The *grub rtsis* values are given *passim* in *Phug pa* texts. For example, for Nor bzang rgya mtsho, see Kilty (2004: 31), Henning, "Siddhānta Calculation Systems *Grub rtsis*," [2015]. In the case of Phyag mdzod, see Huang and Chen (1987: 12, 149); Henning (2007: 328); Henning, http://www.kalacakra.org/calendar/os_tib.htm : *gza' dag*: 1;38 [= $1^{z}38^{q}$], *zla skar*: 16;0 [= $16^{k}0^{q}$], *nyi dag*: 2;30 [= $2^{k}30^{q}$], Rāhu (Sgra gcan gdong): 16;29 [= $16^{k}29^{q}$]. It is verified from the values of *zla skar* and Sgra gcan gdong that the lunar eclipse is possible. Also in Henning's software version 1.06, choose "generalised *Phug pa*" -> choose "Calendar cycle" -> input 15 (date)/ 4 (month)/ - 926 (year). (Julian day: 1382912. Western date: March, 17, −926 (= 927 B.C.E.)). *gza' dag*: 1;38:39:0:306 (7;60:60:6:707) [= $1^{z}38^{q}$39'0"306"' (7/60/60/6/707)], *zla skar*: 15;59:53:1:47 (27;60:60:6:67) [= $15^{k}59^{q}$53'1"47"' (27/60/60/6/67)], *nyi dag*: 2;29:53:1:47 (27;60:60:6:707) [= $2^{k}29^{q}$53'1"47"' (27/60/60/6/67)], *sgra gcan gdong*: 16;29:36:3:3 (27;60:60:6:23) [= $16^{k}29^{q}$36'3"3"' (27/60/60/6/23)]. To see the *byed rtsis* values of 927 B.C.E. (*shing rta*)/4/15 [= the date given by *Phug pa* as that of the lunar eclipse at the Buddha's enlightenment], see Sum pa Mkhan po's calculation included in the *Dpag bsam ljon bzang*: See below p. 68. In that case, too, *sgra gcan gdong* [= $16^{k}29^{q}$36'3"3"' (27/60/60/6/23)] is very close to *tshes 'khyud zla skar* [$16^{k}27^{q}$46'0"9"'(27/60/60/6/13)], which means the lunar eclipse is not possible. For Sum pa Mkhan po's interpretation of the values, see below page 69 and note 152.

yin te / de'i nyin rtsis la gza' gcig / chu tshod so brgyad / zla ba'i skar mar bcu drug / chu tshod stong pa ste tshes 'khyud do / nyi ma'i skar ma gnyis / chu tshod sum cu / sgra gcan rtsa ba'i skar mar bcu / chu tshod sum cu / gdong gi skar mar bcu drug / chu tshod nyer dgu 'char ba'i phyir ro /[95]

[Buddha] attained enlightenment in the year called *rgyal ba* (S. *jaya*),[96] wood-male-horse year (927 B.C.E.). ... The statement in *Lalitavistara sūtra* that [Buddha] attained enlightenment when the constellation arrived at *sa ga* (S. *vaiśākhā*) merely intends the constellation connected to the full moon day according to the mentioned previously logic, but, if done in a detailed way, it is because the constellation of the time of attaining enlightenment is *lha mtshams* (S. *anurādhā*) and the date is also the 16^{th} whose *nyin rtsis*[97] appears as follows[98]: *gza'* $1^{z}38^{q}$, *tshes 'khyud zla skar* $16^{k}0^{q}$, *nyi ma* $2^{k}30^{q}$, *sgra gcan rtsa* $10^{k}30^{q}$, *sgra gcan gdong* $16^{k}29^{q}$.

The figures (T. *ri mo*), which were presented above to indicate the lunar eclipse at the Buddha's enlightenment, are those of 927 (*shing rta* year)/4 (*sa ga* month)/15 (*tshes zhag*). After presenting the values as such, Grwa phug pa presents the same Buddhist texts that Rtogs ldan had used. He maintains that his calculation tallies with the aforementioned Buddhist *sūtra*s stating that when the Buddha attained the unsurpassable wisdom, the moon was held by Rāhu.

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[95] Grwa phug pa (1980: *ka* 56b-57a) [= Grwa phug pa (2002: 83-4)]. A similar and redundant account is found in 'Phrin las dge ba'i dbang po (2002: 594-6).

[96] For this system, see my appendix I.

[97] The *nyin rtsis* is a daily calculation. Therefore, the term cannot be applied to *gza' dhru*, *nyi dhru*, etc. because they are the same during a month. The calculations of *gza' dag*, *nyi dag*, *lnga bsdus*, etc. are called *nyin rtsis*.

[98] By 927 B.C.E./4/16, he means the transition moment between the 15^{th} day and the 16^{th} day, which is set as the time of lunar eclipse according to the Tibetan *skar rtsis* system. Given the value of *tshes 'khyud zla skar* $16^{k}0^{q}$ and that of *sgra gcan gdong* $16^{k}29^{q}$, it is possible that the lunar eclipse happens on 927 B.C.E./4/15. In other words, the moon was held by the head of the Rāhu (*sgra gcan gdong*).

A later scholar 'Ju Mi pham (1846-1912) summarizes the *Phug pa*'s ideas on the *tshes rtsis*[99] at the Buddha's enlightenment and the occurrence of the lunar eclipse on the basis of the *Vaiḍūrya dkar po* of the Sde srid, another *Phug pa* scholar.

> *phug pa'i pad dkar zhal lung gi rjes 'brangs baiḍur dkar po dang / rtsis gzhung nyin byed snang ba'i bzhed pa ltar na ston pa shākya'i rgyal po nyid / ... shing rta sa ga zla ba'i tshes bco lnga'i tho rangs kya (sic. skya) rengs 'char ba'i dus su mngon par rdzogs par sangs rgyas / de nyin gyi tshes rtsis dang gza' dang gza' 'dzin ri mo btab pas gdong 'dzin yod pas sangs rgyas tshe zla ba gzas bzung bar gsungs pa dang 'grigs /*[100]

> According to the assertion of *Vaiḍūrya dkar po*, which follows *Phug pa*'s *Pad dkar zhal lung* and *Rtsis gzhung nyin byed snang ba*, teacher Śākyamuni ... attained enlightenment at the time of *tho rangs*/ *skya rangs*[101] of the 15th day in the month of *sa ga* of the wood-horse year (927 B.C.E.). Because there occurs *gdong 'dzin*[102] by calculating *tshes rtsis*, *gza' dag*, and eclipse value of the day, [it] accords with the statement that the moon was held by Rāhu at the time of the enlightenment.

Next, the following table is presented on the basis of Tibetan texts and modern research. In it, there is a remarkable discrepancy between *byed rtsis* scholars as Bu ston, Mnga' ris Chos rje, and Mkhas grub and *Phug pa*. Albeit the two groups use the same Buddhist texts, which were mentioned above, the Buddha's dates bifurcate.

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[99] For *tshes rtsis*, see *nyin rtsis* in note 96. Both are basically the same.

[100] Mi pham (2012: 1012-3).

[101] *Tho rangs* is one of the *dus tshod bcu gnyis*, 12 two hours of a day. See below note 536. Meanwhile, *skya rangs* is the moment of day-break. Also see Lcang skya III et al. (2002: 1183): *tho rangs* (M. *söni-yin adaγ*): "end of night." The termination of *tho rangs* means the end of the night. Ishihama and Fukuda (1989: 383-4): S. *aruṇodgatam* T. *skya rengs shar ba* [ML] *colbun γarqu buyu ür cayiqu* [MT] *ür geyiküi*. Sárközi and Szerb (1995: 541-2).

[102] For *gdong 'dzin*, see Bsam 'grub rgya mtsho (2011: 94).

Table 3.

	Year of birth	Year of enlightenment	Year of Buddha's *Kālacakra* Teaching	Year of *nirvāṇa*[103]
Bu ston[104]	915 B.C.E. (*me rta*)	880 B.C.E. (*lcags sbrul*)	879 B.C.E. (*chu rta*)	835 B.C.E. (*me stag*)
Mnga' ris Chos rje[105]	915 B.C.E.	879 B.C.E.	878 B.C.E. (*chu lug*)	834 B.C.E. (*me yos*)
Mkhas grub[106]	915 B.C.E.	879 B.C.E.	878 B.C.E.	835 B.C.E.
Grwa phug pa and others (15th c.)[107]	961 B.C.E. (*lcags sprel*)	927 B.C.E. (*shing rta*)	881 B.C.E. (*lcags 'brug*)	881 B.C.E.

[103] Macdonald's minor mistake is seen in Macdonald (1963: 122, no. 59): She holds that the Buddha's *nirvāṇa* falls on 877 B.C.E. in the case of Bu ston and 876 B.C.E. in the case of Mkhas grub. But it is not true. First, the years are not those of *nirvāṇa* but those of the Buddha's *Kālacakra* teaching. Second, both of them are identical in terms of the Buddha's year of *Kālacakra* teaching: Bu ston: 1786 − 2664 = −878 (= 878 B.C.E.), Mkhas grub: 1434 − 2312 = −878 (= 878 B.C.E.). And then we are not puzzled at the understanding of 'Gos Lo tsā ba's chronology described by Lha dbang blo gros in Macdonald (1963: 68) (1963: 68): She holds that according to 'Gos Lo tsā ba's chronology cited by Lha dbang blo 'gros, Mnga' ris Chos rje places the Buddha's *nirvāṇa* in 835 B.C.E. [1592 − (2427 + 1) = − 836 (836 B.C.E.) may be better]. In the case of Bu ston, she maintains that 878 B.C.E. falls on the Buddha's year of the *Kālacakra* teaching. [B.C.E. 1592 – (2470 + 1) = − 879 (879 B.C.E.) may be better]. For relevant remarks, see Vostrikov (1970: 108-9, no. 337), Seyfort Ruegg (1992: 277-9). There may be the difference of one year or so in the Tibetan *bstan rtsis*. For example, in the case of *byed rtsis* scholars, the year of the Buddha's *nirvāṇa* shows various years because it has nothing to do with the *Kālacakra* teaching, unlike *Phug pa*.

[104] Bu ston (1986: 185): 1326 (the year in which *Mkhas pa dga' byed* was written) – (2204 + 1) = 879 B.C.E. (the Buddha's *Kālacakra* Teaching). However, the year of the Buddha's *Kālacakra* teaching in his *Chos 'byung* is problematic. Obermiller (1931–1932: 108): 1322 – (2198 + 1) = 877 B.C.E. (the Buddha's *Kālacakra* Teaching). Something is wrong here. For this year, see also Vogel (1991: 411, no. 90), and Seyfort Ruegg (1992: 278).

[105] Mnga' ris Chos rje (2008: 11), Seyfort Ruegg (1992: 277-8).

[106] See Mkhas grub (1897: 27b). See also Vostrikov (1970: 108-9), Seyfort Ruegg (1992: 279), Zabel (1992: 294), Bsod nams rin chen (2009: Vol. 2, 190), Van der Kuijp (2013: 141-5, especially 141-2, no. 60, 144, no. 62).

[107] See Grwa phug pa (2002: 83-5), Nor bzang rgya mtsho (2004: 26-35), Henning (2007: 149-54, 365-8), Seyfort Ruegg (1992: 277).

As seen above, when deciding the year in which the Buddha taught the *Kālacakramūlatantra*, both groups commonly used the lunar eclipse at the time of Buddha's enlightenment as stated in the aforementioned Buddhist texts, but they presented the following different years: 879 B.C.E. (*chu rta*) in the case of Mhas grub; 927 B.C.E. (*shing rta*) in the case of *Phug pa* scholars. The reason why their presentations of the years are different is that the possibility of the lunar eclipse is calculated differently: In the former, the lunar eclipse occurred in 879 B.C.E., but, in the latter, it occurred in 927 B.C.E.. Simply, the common rationale for the decision of the different Buddha dates is *yar log gi rtsis*. As a result, the former holds that the *Mūlatantra* was taught after the Buddha's enlightenment, and the latter maintains that it was taught before the Buddha's *nirvāṇa*.

In the following, let me tackle Sum pa Mkhan po, who was most vigilant of the astronomical phenomena and traditions among 18th century astronomers, to see the relationship between the logic of *yar log gi rtsis* centering around eclipse calculation and the accuracy of an astronomical system.

2. A SURVEY OF LATER PERIOD *BSTAN RTSIS* WITH RESPECT TO AN ECLIPSE

SUM PA MKHAN PO: REAPPRAISAL FOR *BYED RTSIS* AND THE ECLIPSE CALCULATION

In the 18th century atronomical context, Sum pa Mkhan po is an important scholar who has a sense of the diverse traditions, including Mongolia and China, although he mainly stands on the shoulders of the Tibetan giants of the previous centuries. The reason why he should be mentioned is that, through him, we can read that the previous tradition was well digested and rejuvenated, and we can also understand what astronomical ideas and thoughts were dominant in his period.

About the eclipse calculation at the Buddha's enlightenment, he adhered to the time-honored *skar rtsis* exegesis. He shared the same ideas with his predecessors.

> *de kun gyis rang rang gi gang smos dang bstun pa'i sangs rgyas pa'i lo re bzhag ste de dang de'i sa ga'i nya la sangs rgyas pa'i tho rangs zla 'dzin yod par 'dul lung du gsungs ltar 'grigs zer yang / yar slog gi ri mos bltas na de yod pa re tsam las mi snang bas phal cher gyi rang gzhung la nang 'gal 'byung ngo /*[108]

> All of them (the different opinion holders on the *bstan rtsis*) put forth the individual year of the enlightenment, which accords with individual opinion whatever it is, and alleged that they accord with the *Vinaya sūtra* stating that the lunar eclipse occurred at the daybreak of the full moon day of the month of *sa ga* such and such, but, because given the figure by backward calculation, the occurrence of the lunar eclipse does not appear except for a few, internal contradiction occurs to most of their own texts.

Intriguingly, he, as a *Phug pa* scholar, did not follow *Phug pa* predecessors' exegesis in terms of the calculation of the lunar eclipse at the Buddha's enlightenment. Instead, he followed Mkhas grub, who is a *byed rtsis* scholar, as is clearly seen below.[109]

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[108] Sum pa Mkhan po (1979: 287b) [= (1992: 917)].

[109] Bud 'joms 'jigs bral ye shes rdo rje translated in 'Gyur med rdo rje (1991: 946).

Table 4.

	Year of birth	Year of enlightenment	Year of Buddha's *Kālacakra* Teaching	Year of *nirvāṇa*
Mkhas grub	915 B.C.E.	879 B.C.E. (*chu rta*)	878 B.C.E.	835 B.C.E.
Sum pa Mkhan po	915 B.C.E.	879 B.C.E.	878 B.C.E. [110]	834 B.C.E. [111]

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[110] See Sum pa Mkhan po (1979d: 292b) [= (2001: 758)]: "From the water-female-sheep year (878 B.C.E.) in which Bhagavān spoke in the *Kālacakra*, King of Tantra," (*bcom ldan 'das kyis rgyud kyi rgyal po dus kyi 'khor lo las gsungs pa'i chu mo lug lo nas ...*). Also, see Nishioka (2007: 448). However, there is something wrong in the statements on the year of the Buddha's *Kālacakra* teaching in Sum pa Mkhan po's autobiography. For example, Sum pa Mkhan po (1979d: 166b) [= (2001: 430)]: "on the 14th day of the *śuklapakṣa* in the third month ... of the year in which 2655 years passed from the year Jina (Buddha) preached *Kālacakra*, [which is] called *manmatha* in Sanskrit, *myos byed* according to the *Bde mchog stod 'grel* in the *Laghutantraṭīkā*, *yiwei* (Ch. 乙未) in great China's language, *kökegčin qoni* in Mongolian (*hor*), and the wood-female-sheep year in Tibetan." (*rgyal bas dus 'khor gsungs lo nas nyis stong drug brgya nga lnga 'das pa'i gnam lo sam skrī ta'i skad du mar* (*ma ra* ?) *dang stod 'grel lugs la myos byed dang ma hā tsi na'i skad du yi wa'i dang hor gyi skad du khu khug chin ho ni dang bod skad du shing mo lug lor 'bod pa'i ... ming gzugs kyi yar ngo'i yar tshes stong ba gsum pa'i nyin ... .*). The date is 1775/3/14. For *stong ba gsum pa*, see the following table.

		dga'	*bzang*	*rgyal*	*stong*	*rdzogs*
dkar phyogs	*dang po*	1	2	3	4	5
	gnyis pa	6	7	8	9	10
	gsum pa	11	12	13	14	15
dmar phyogs	*dang po*	16	17	18	19	20
	gnyis pa	21	22	**23**	24	25
	gsum pa	26	27	28	29	30

For the textual basis of this table, see Phyag mdzod, Huang and Chen (1987: 27, 175-6), Bsam 'grub rgya mtsho (2011: 86-7). For the equation of each year according to see Tibetan, Mongolian and Chinese methods, see Appendix I. Especially, for the Tibetan method in the *Bde mchog stod 'grel* seen in Vajrapāṇi's (T. Phyag na rdo rje. circa 10th ~ 11th c.) *Laghutantraṭīkā*, see Cicuzza (2001: 33): "We do not know the origin of 18 stanzas and six astronomic stanzas (in which the name of the Jupiter sexagenary cycle is mentioned). Also read Newman (1998: 344). And for the *ming gzugs*, see Lcang skya III et al. (2002: 1174-5): one of the synonyms of the *zla ba gsum pa* (*γutaγar-a sar-a*) is *ming gzugs zla* (M. *ner-e üngge-yin sar-a*). Also see Bsam 'grub rgya mtsho (2011: 156). Going back to my point, 1775 − (2655 + 1) = 881 B.C.E. is calculated as the year of the Buddha's *Kālacakra* teaching. This is strange given the fact that the Buddha's preaching *Kālacakra* was placed in the year of 878 B.C.E. according to his exegesis. Another example in the same text: Sum pa Mkhan po (1979d: 74b) [= (2001: 193)]: "on the sixth day of the *śuklapakṣa* in the sixth month according to *skar rtsis* tradition ... in the *chu stod* (the 6th month) month of the [year in which] 2600 [years] passed after Bhagavān's having preached the *Dus 'khor rgyud kyi rgyal po*, the year (T. *zla ba'i 'phreng can*) in the 12th *rab byung*, which is called *rākṣasa* in Sanskrit, *srin po* according to the *Bde mchog stod 'grel*, *yimao* (乙卯) in great China's language, the wood-female-hare in Tibet." — I do not translate *lo'i mdzod* which means month. If translated, it would be redundant. — (*bcom ldan 'das kyis dus 'khor rgyud rgyal gsungs pa nas ... nyis stong drug brgya 'das pa rab byung bcu gnyis pa'i nang tshan gyi gnam lo sam skrī ta'i skad du raksha sa dang*

His response to Paṇ chen Blo bzang dpal ldan ye shes's (1738–1780) 1777's (T. *me bya*) questions in 1778 C.E. (*sa khyi*) shows his reappraisal of *byed rtsis*.

> *... bcom ldan 'das sangs rgyas pa'i sa ga'i nya'i tho rangs la gza' 'dzin ri mo'i lam nas nges par e 'char / ... lan thal mo sbyar te gsol ba ni / ... mdo na rgyal po (sic. read bu) don kun grub pa gsar du sangs rgyas tshul ston pa'i sa ga'i nya de mtshan mo sgra gcan 'dzin 'khrungs pa dang zla ba sgra gcan gyis zin par gsungs pa dang mthun par byed ched du / mkhas pa so sos rang lugs kyis bcom ldan 'das sangs rgyas lo re bzhag ste de'i sa ga'i nya la de lta'i ri mo re 'grig par mdzad kyang dngos gzhi gang yin kha tshon gcod dka' la / 'on kyang mkhas pa la las de la grub rtsis nges la byed rtsis la ri mo de lta bu shar yang mi nges zhes pa'i lan 'debs phyir du / bu ston rin po che dang mkhas grub thams cad mkhyen pa dang chos mgon rnams kyi lugs kyi byed rtsis zhib pa ltar 'thad pa sgrub phyir du khong rnams kyis bzhed pa'i lo zla de'i nyin zhag gi tho rangs gza' 'dzin yod pa rtsis gsar la'ang 'grig par byas pa'i ri mo ni zla bshol zhig dang nye yang de kho dag par yod lags /*[112]

> ... With my hands folded in devotion, replying to [your] questions, "does Bhagavān's attainment of enlightenment at the daybreak of the full moon day in the month of *sa ga* certainly occur by the value of eclipse?" is as follows: ... In order to make it agree with the statement in the *sūtras*[113] that Rāhula was born at the night of the full moon day of the month of *sa ga* when prince Siddhārtha newly showed the way of enlightenment and the moon was held by Rāhu, individual learned scholars put forth the respective year of Bhagavān's enlightenment by their own traditions and accorded with each value like that on the full moon day of the month of *sa ga*, but it is difficult to decide the actual basis, nonetheless. However, the values of the occurrence of the eclipse at daybreak of the

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stod 'grel ltar na srin po dang / ma hā tsi na'i skad du yi ma'u dang bod du shing mo yos su 'bod pa'i zla ba'i 'phreng can gyi ... chu stod zla ba'i lo'i mdzod gyi ... skar rtsis lugs kyi zla ba drug pa'i dkar cha'i tshes drug ... .) The date is 1735/6/6. For the *chu stod zla ba*, see Lcang skya III et al. (2002: 1174-8). For the synonyms of the year, see Appendix I. Going back to my point, this is also strange: 1735 – (2600 + 1) = 866 B.C.E. is given as the year of the Buddha's *Kālacakra* teaching. It is not 878 B.C.E. most probably because of a miscalculation of the duodenary cycle into the sexagenary one.

111 See Vostrikov (1970: 108-9), Seyfort Ruegg (1992: 287), and Zabel (1992: 295, 297).

112 Sum pa Mkhan po (1979c: 5a).

113 They include *Vinaya sūtra*, *Abhiniṣkramaṇa sūtra, Lalitavistara sūtra*, etc.

> month in the year asserted by Bu ston, all knowing Mkhas grub, and 'Jam dbyangs chos kyi mgon po[114] in order to reply to some scholars' statements regarding that *grub rtsis* is certain but [*byed rtsis*] is not, even if the values occur in *byed rtsis*; in order to prove the agreement according to the accurate *byed rtsis* of their traditions, which are also in accordance with *Dga' ldan rtsis gsar*, are close to intercalation and correct.[115]

He defends the *byed rtsis* of Bu ston and Mkhas grub. The ground is the accuracy of eclipse calculations. He explains that the lunar eclipse at the Buddha's enlightenment occurred on 879/4/15 according to their *byed rtsis* system. Therefore, the accuracy of his own system *Dga' ldan rtsis gsar* is also justified.

In the section on Mkhas grub in his *Dpag bsam ljon bzang*, through which we can learn of Sum pa Mkhan po's ideas and reasoning concerning the relationship between *bstan rtsis* and eclipse calculation, the motivation to create the *Dga' ldan rtsis gsar*, the assessment of the existing systems, and his siding with *byed rtsis*. First, he cites Mkhas grub's statements in the *Great Commentary* that was criticized by Grwa phug pa, and Grwa phug pa's criticism of Mkhas grub in the *Pad dkar zhal lung.* Then, he defends Mkhas grub.[116]

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[114] Tentatively, I adopt the research by Kaḥ thog Rig 'dzin (1976-1977) (2006) for the identity of this man, for which see above p. 42.

[115] Sum pa Mkhan po (1979c: 5a-5b).

[116] Van der Kuijp (2013: 142, n. 60). Mkhas grub's Buddhist chronology, which places the Buddha's enlightenment in 879 B.C.E. (*chu rta*), has been understood to be problematic among Tibetan scholars. But Sum pa Mkhan po defends Mkhas grub's chronology based upon *byed rtsis*. Sum pa Mkhan po (2001: 309-10): "Also, some learned scholars in calculation say that, although Mkhas grub wrote *the Great Commentary* on *Kālacakra*, he has narrow outlook even to *lnga bsdus* (S. *pañcāṇga*), ... the condition that I put some answers to the refusal by some in this [= my] calculation and *Chos 'byung* is: Sgo mang Bla ma Sems nyid dam chos, having studied calculation, intended to answer, but there was no opportunity. Upon this, when Seng lding zhabs drung came from Dbus to Amdo [= before Seng lding zhabs drung's coming to Amdo from Dbus], he said, "You ask Sum pa Mkhan po to answer." Because I could not refuse the statement [made by Sgo mang

de nang gi dgag pa 'ga' zhig dang mdzad byang sogs mkhas pa lhun 'grub rgya mtsho pas sbyar ba de las bod kyi mkhas pa du ma'i bstan rtsis so sor dgag cing / khyad par du mkhas grub rje bkag pa'i thad du dpyad pa byed dka' mod kyang ... mkhas grub rje'i ṭik chen par ma na / sangs rgyas kyi (sic. read *kyis) rtsa rgyud gsungs pa'i lo dang de'i rjes su zla bzang gis shambha lar lo gcig gi ring la rtsa rgyud bstan cing 'grel ba brtsams te dus kyi 'khor lo'i gzhal yas khang bzhengs nas mya ngan las 'das pa'i lo gcig ste lo gnyis po de ni sngar gyi grangs las logs su lhag por bgrang dgos te / ston pas rtsa rgyud ston pa'i lo 'di nas 'og tu drug brgya'i lo yis zhes pa yin pas / lo drug brgya po de'i sngon ma rtsa rgyud ston pa'i dus de la bzung bas lo gnyis po ni lo 'di nas ni drug brgya zhes pa'i khongs su ma gtogs pa'i phyir ro / zhes dang /*[117] *sa ga'i nya'i tho rangs kyi cha la sangs rgyas shing de'i tshe zla ba gzas zin par bshad la / de'i lo de nyid chu pho rta sna tshogs kyi lo yin te / de la sngar bstan rtsis kyi skabs su ji skad bshad pa'i 'das lo'i grangs gzhir bzhag pa'i steng nas lugs bzlog gi rtsis byas te / lo de'i sa ga'i zla ba'i zla dag btsal nas de'i nya'i nyin rtsis byas pa na ... gza' 'dzin dang legs par 'grig par 'gyur ba'i sngar gyi bstan rtsis kyi 'das lo 'jog tshul sogs rnam par dag cing yid brtan du rung bar 'grub la /* [continued below]

Sum pa Mkhan po's Table A.[118]

1	14	1	26	0	14
37	21	28	14	45	15
43	15	58	13	46	46
5	0	5	0	5	5

Bla ma Sems nyid dam chos], I wrote [the contents in this calculation and *Chos 'byung*]." (*yang rtsis la mkhas pa la las mkhas grub rjes dus 'khor 'grel chen brtsams kyang rtsis kyi lnga bsdu (sic.* read *bsdus) tsam la'ang spyan dkyus thung zhes zer ba dang / ... rtsis 'di dang chos 'byung du kha cig gis mkhas grub rje dgag pa'i lan 'ga' zhig btab pa'i rkyen ni / sgo mang bla ma sems nyid dam chos pas rtsis sbyangs nas de'i lan 'debs dgongs kyang de'i long skabs ma byung ba na seng lding zhabs drung dbus nas a mdor yong dus su khyod kyis sum pa mkhan po la zhus nas de'i lan 'debs chug gsungs pa'i bka' bzlog ma nus nas bris pa yin no /*).

117 Mkhas grub (1897: 27b): The *Zhol par ma* is nearly the same. The difference is underlined in the following: *sangs rgyas kyi* (*sic.* read *kyis*) *rtsa rgyud gsungs pa'i lo dang de'i rjes su zla bzang gis shambha lar lo gcig gi ring la rtsa rgyud bstan cing 'grel ba brtsams te dus kyi 'khor lo'i gzhal yas khang bzhengs nas mya ngan las 'das pa'i lo gcig ste lo gnyis po de ni sngar gyi grangs las logs su lhag por bgrang dgos te / ston pas rtsa rgyud ston pa'i lo 'di nas 'og tu drug brgya na lo yis zhes pa yin pas / lo drug brgya po de'i sngon ma rtsa rgyud ston pa'i dus de la bzung bas lo gnyis po ni lo 'di nas ni drug brgya ces pa'i khongs su ma gtogs pa'i phyir ro / .*

118 The value of this table is that of *byed rtsis* at 879 B.C.E. (*chu rta*)/4/15. *res 'grogs zla skar* $14^{k}21^{q}15'0''3'''$, *mjug* $14^{k}15^{q}46'5''10'''$. *tshes 'khyud zla skar* = *res 'grogs zla skar* + *gza' dag* (The *gza' gnas* is irrelevant to this calculation. The values of the *chu tshod* and below are considered. i.e. $37^{q}43'5''5'''$) = $14^{k}58^{q}58'5''8'''$. The difference between *tshes 'khyud zla skar* and *mjug* is around 43^{q}; thus, a lunar eclipse is a possibility. For the term *res 'grogs zla skar*, see Janson (2014: 29).

Sum pa Mkhan po's Table A (continued)

5	3	8	3	10	10
gza'[119]	*zla skar*[120]	*nyi skar*[121]	*rtsa*[122]	*gdong*	*mjug*

rtsa rgyud bstan pa'i lo dang zla bzang gis chos bstan pa'i lo gnyis drug brgya'i khongs su bgrangs nas rtsis na gza' 'dzin gyi ri mo 'di mi char la / gcig ma bgrangs par rtsis na 'grig 'ong bar mngon sum gyis grub pas / zhes[123] *sangs rgyas pa'i lo gsungs pa de zhal lung du 'gog pa na /*[124] *yang ṭī ka mdzad pa kha cig gis rgyud 'chad pa'i thog mar bstan rtsis mdzad pa na rtsa rgyud gsung ba'i lo dang zla bzang gis shambha lar 'grel ba rtsom pa sogs kyi lo gcig ste / lo gnyis po de ni lha dbang sogs kyi drug brgya las logs su bgrang mi dgos te drug brgya po'i khongs su gtogs pa'i phyir ro / zhes bkod nas slar yang 'og tu lo 'di nas ni drug brgya'i lo yis zhes sogs rgyud kyi lo dag pa 'char ba'i skabs su rtsa rgyud bstan pa'i lo dang / zla bzang gis chos bstan pa'i lo gnyis ka drug brgya'i khongs su bgrang na gza' 'dzin gyi ri mo 'di bzhin mi 'char la / gcig ma bgrangs par brtsis na 'grig 'ong ba mngon sum gyis grub pas zhes pa dang / sngar bstan rtsis kyi skabs su bstan pa'i 'das lo'i grangs gzhir bzhag nas yar log gi rtsis byas na chu pho rta sna tshogs kyi lo'i sa ga'i nya'i gza' 'dzin la sogs pa 'char zhes bkod nas gza' 'dzin gyi ri mo lugs snga mas bzhag pa de nyid bris snang ngo / 'di dag la ni gong 'og 'gal ba dang / rang gi bstan rtsis kyi lo grangs gzhir bzhag na yar log gi gza' 'dzin mi 'char ba dang / lugs snga ma'i (chos sogs) rjes su 'brangs 'dug pa la 'di la'ang rjes su brjod pa yod pa'i nyes pa ste nongs pa gsum gyis reg go / zhes gsung ... .*[125]

In some criticisms and colophon, etc., in it (*Pad dkar zhal lung*), which was written by master Grwa phug pa, [he] refused *bstan rtsis*-s of many learned scholars of Tibet,

[119] *gza' dag.*

[120] *res 'grogs zla skar.*

[121] *nyi dag.*

[122] *Sgra gcan rtsa*, *gdong*, *mjug*: the unit of *cha shas* is given as 13.

[123] The quotation from *sa ga'i nya'i* to *grub pas* is found in Mkhas grub (1897: 390b-391a).

[124] Grwa phug pa (2002: 23). This passage from *yang ṭī ka* to *reg go* is from Grwa phug pa (2002: 23-4). Grwa phug pa meant Mkhas grub (1897: 27b) by the quotation from *rtsa rgyud gsung ba'i* to *phyir ro*; Mkhas grub (1897: 390b-391a) by the quotation from *lo 'di nas* to *mngon sum gyis grub pas*; Mkhas grub (1897: 390b) by the quotation from *bstan pa'i 'das lo'i* to *la sogs pa 'char.*

[125] Sum pa Mkhan po (1979: 179b-180a) [= (1992: 541-3)].

respectively, and especially the analysis regarding the refusal of Mkhas grub is difficult but ... . It is stated in the block print of Mkhas grub's *Great Commentary* that the year in which Buddha spoke the *Mūlatantra* (878 B.C.E.) and ensuingly the year in which Sucandra taught the *Mūlatantra* and wrote a commentary in Śambhala and passed away after having built *Kālacakra* celestial palace during one year (878 B.C.E.) is the same year. The two years should be calculated separately, additionally, from the previous numbers because it is stated "by the 600 years onwards from the year Buddha taught the *Mūlatantra*," the two years before the 600 years do not belong to the quotation "600 years from this year" because the 600 years begin from the time Buddha taught the *Mūlatantra.* It is explained [in Mkhas grub's *Great Commentary*] that the Buddha attained enlightenment at the moment of the daybreak of the month of *sa ga*, and at that time, the moon was held by Rāhu*,* and the year is water-male-horse year *citrabhānu* (879 B.C.E.). If having reversely calculated from that which was put on the basis of the elapsed years stated in the case of the previous *bstan rtsis*, [ ] calculate *nyin rtsis* of the full moon day for that, after having sought *zla dag* (true month) in the month of *sa ga* of the year, ... the method of setting *'das lo* (elapsed years), etc. of the previous *bstan rtsis*, which nicely accords with the eclipse, etc. are pure and reliable. If calculated counting the two years, the year in which [Buddha] taught the *Mūlatantra* and the year in which Sucandra taught the dharma, within the 600 years, the value of the eclipse does not arise, but if calculated without counting one year, [ ] established by direct experience (*mngon sum*)[126] in a way that the eclipse occurs.

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[126] Tibetan scholars and astronomers who have training in Buddhist epistemology (T. *tshad ma*) use the concept of direct perception (S. *pratyakṣa*/ T. *mngon sum*) in a way that whether an astronomical system is accurate or not is verified by direct perception of eclipse, solstice, equinox, etc. This also means that they should produce a system that matches up with the real celestial phenomena. This idea is time-honored. To illustrate some, G.yung ston states in a correspondence between him and Bu ston included in Dharmaśrī (1983: 286-7): "... shouldn't be afraid when punishing [ ] after having built the court in which the text containing my commentary to the *Kālacakratantra*, the calculation, i.e. the reason — this is my interim rendering for *rgyu mtshan rtsis* — shown through arithmetic, wisdom on the basis of real things (T. *dngos po stobs zhugs*. S. *vastubalapravṛtta*), and non-erroneous direct perception of eye consciousness assemble together?" (*... nga'i rgyud 'grel pa dang bcas pa'i lung dang / sa ris kyi lam nas ston pa'i rgyu mtshan rtsis dang / dngos po stobs zhugs kyi rigs pa dang / mig shes ma 'khrul ba'i mngon sum rnams 'dzoms pa'i khrims ra bcas nas btsa'* (*sic.* read *rtsa*) *ra byas dus mi skrag pa e yin /*). For this pasage, see Tshul khrims chos 'byor (1982: 28) without indicating a proper source of citation. Van der Kuijp (2007: 144) indicates the source rightly. In it, G. yung ston clearly states several conditions for being an accurate calculation / astrologer, one of which is "direct perception of eye consciousness." Another example: Byang bdag's letter to Mkhas grub, Byang bdag (2) (n.d.: 9b): "Bhagavān also said some *byed rtsis* in calcuation, the means to realize it. Even if it is the case, it would not be the case of knowing calculation just by knowing *byed rtsis* a little, and if [you] can show the understanding of reason and the signs of pleasure and pain of the three times by direct perception, it would be the case that [you] know calculation, but not in other cases." (*de rtogs par byed pa'i thabs / rtsis kyi byed pa 'ga' yang / bcom ldan 'das kyis gsungs yod / de lta na yang / byed rtsis cung zad tsam shes pas rtsis shes par mi 'gyur zhing / rgyu mtshan rtogs pa dang / dus gsum gyi bde sdug gi mtshan ma mngon sum du ston nus na / rtsis shes par 'gyur gyi / gzhan du na ma yin no /*). Another example, Sum pa Mkhan po's second letter to Ngag dbang nyi ma in 1785/1786, Sum pa Mkhan po (1979c: 91b): "... That being so, because whether my son-text (*Zla bsil rtsi sbyor dge ldan rtsis gsar*) is accurate or not is easily known by calculating and checking whether annual solstice, eclipse, etc. accord with their being seen (T. *mig mthong*), [ ] is the object of direct perception without needing the argument of hidden (T. *lkog gyur*) means of knowing and elaborated words, etc. to them." (*... de bas na bdag gi bu gzhung dag mi dag ni lo re bzhin gyi nyi ldog gza' 'dzin sogs bris nas mig mthong dang 'grig mi 'grig bltas na shes sla pas / de dag la lkog gyur rtogs byed ltar gyi gtan tshigs dang tshig 'phres* (*sic*. possibly *'phros*) *sogs mi dgos bar mngon gsum gyi yul yin no /*). As a matter of fact, it is not difficult to find the concept of *mngon sum* used in *rtsis* texts. Tibetan astronomers use it *passim*: an eclipse is manifest by

[Grwa phug pa] refutes in the *Pad dkar zhal lung* the (Mkhas grub's) statement of the year of enlightenment saying: Also, the person who wrote the *Ṭīkā* (= Mkhas grub) wrote that, at the beginning of the explanation of the *Tantra*, the year of the *Mūlatantra* teaching and the year of Sucandra's writing a commentary in Śambhala are the same and the two years do not need to be counted separately from the 600 years of Sureśvara, etc. because [they] belong to the 600 years. And then, [he (= Mkhas grub)] wrote below that on the occasion of the rise of *lo dag pa*[127] of *Laghukālacakra* and *Vimalaprabhā* stating "by six hundread years from this year onwards," etc., if the two years, i.e., the year in which the *Mūlatantra* was preached [by Buddha] and the year in which Sucandra taught dharma are calculated, being included in six hundread years, the values of of the occurrence of the eclipse do not arise like this, and if [one] calculates without counting one of them, the occurrence of the eclipse is established by *mngon sum*. And [Mkhas grub] stated that if [one] performs backward calculation by being based on the numbers of the elapsed years stated in the case of the previous *bstan rtsis*, the eclipse, etc. on the full moon day of the month of the *sa ga* in the year of water-male-horse *citrabhānu* (879 B.C.E.) appear. And then the values of the eclipse, which were put forth by the previous tradition, were written [in Mkhas grub's *Great Commentary*]. [Grwa phug pa continuously] says that these [= Mkhas grub's theory] are subject to the three mistakes: (1) the contradiction between earlier and later statements [in Mkhas grub's *Great Commentary*]; (2) if put by being based upon the numbers of the years according to the *bstan rtsis* of the *Phug* system, the eclipse calculated backward does not arise; (3) the fault that follows, and in addition, merely repeats the previous ('Jam dbyangs Chos kyi mgon po, etc.).

Immediately after the introduction of Grwa phug pa's criticism of Mkhas grub's *bstan rtsis* in the above passage, Sum pa Mkhan po's defense against the three criticisms by Grwa phug pa is as follows. First, for the Grwa phug pa's first criticism, which is an inner contradiction in Mkhas grub's *Great Commentary* that "*lo gnyis po*" (both years, i.e., the year in which the Buddha taught the *Kālacakra* and the year in which Sucandra built the *maṇḍala.* Both indicate 878 B.C.E.)[128] were included and excluded in the "600 years", he

direct perception / direct experience, and if *rtsis* (calculations) is compatible with the occurrence of an eclipse in a system, it means that accuracy of the system is verified.

[127] The *lo dag pa is* true elapsed years during a particular period.

[128] As a matter of fact, Mkhas grub's explanation is confusing and misleading. The "two years" seem to mean the same year 878 B.C.E., not 879 and 898 B.C.E.

points out that Grwa phug pa made a wrong citation.[129] Sum pa Mkhan po is right in that the two years do not belong to the "600 years" and should be calculated additionally. Then, why did Mkhas grub say "*lo gnyis po*," not "*lo gcig po*" (one year)? It is still a difficult question, but Sum pa Mkhan po's following interpretation may be related to the "*lo gnyis po*": the difference of the value of *ril bo*, which is decided by *'das lo* and *zla dag*, produces different *gza' dhru* and *nyi dhru*. Then, the eclipse will occur in 879 B.C.E. according to Mkhas grub's *yar log gi rtsis* calculated according to *byed rtsis*.[130] All in all, Sum pa Mkhan po agrees with and defends Mkhas grub, arguing if the Buddha's *Kālacakra* teaching and Sucandra's writing a commentary to it occurred in 878 B.C.E., and 878 B.C.E. is not

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[129] Sum pa Mkhan po (1979: 180a) [= Sum pa Mkhan po (1992: 543)]: "the absence of the quotation cited by Grwa phug pa from it (= the statement in Mkhas grub's *Great commentary*), '[the two years are] counted being included [within the 600 years] without being counted additionally,' is as was cited previously [by me (= Sum pa Mkhan po)]." (*... de las logs su mi bgrang bar de'i khongs su bgrang zhes pa med pa sngar drangs zin ltar yin la ... .*). Sum pa Mkhan po shows that Grwa phug pa's citation of Mkhas grub is groundless. Actually, Grwa phug pa's citation is the complete opposite to that of Mkhas grub. For the original text of Mkhas grub, see the above Sum pa Mkhan po's citation of Mkhas grub and Mkhas grub (1897: 27b). Why did this kind of miscitation happen? There may be some possibilities: Grwa phug pa either relied on different manuscripts/ block prints or he simply misread Mkhas grub.

[130] Sum pa Mkhan po (1979: 180a-180b) [= (1992: 543-4)]: "The statement of counting one year from the previous two years in (Mkhas grub's) *Great Commentary*, regarding the lunar eclipse in the night of the enlightenment, is: ... for the values of the eclipse of the night. If you ask how it is so, it is said that it would agree in a way that the eclipse occurs that night if backward calculation is performed after adding 10 months and 15 days, without counting the *ril bo* of the previous year (879 B.C.E.) after counting the *ril bo* of the year in which [Sureśvara] built *maṇḍala* (878 B.C.E.) from the previous two years (879 and 878 B.C.E.) on top of the 600 elapsed years." (*sangs rgyas pa'i nub mo'i zla 'dzin thad du ṭik chen las lo snga ma gnyis las gcig bgrang gsungs ni ... de nub kyi gza' 'dzin ri mo'i ched du ste / de ji ltar zhe na lo drug brgya sogs 'das lo'i steng du lo snga ma gnyis las blos bslang bzhengs lo ril bo bgrang nas de'i sngon ma'i lo gcig po ril bo mi 'dren par de'i zla ba bcu dang zhag bco lnga bsnan nas yar log gi ri mo bris na de nub gza' 'dzin yod par 'grig 'ong zhes pa'o /*). In other words, the use of "two years" and "one year" may be contextual in conjunction with the lunar eclipse at the Buddha's enlightenment according to Sum pa Mkhan po's interpretation.

included in the "600 years", the *byed rtsis* value for 879 B.C.E./4/15 tallies with the lunar eclipse at the Buddha's enlightenment.

Next, Sum pa Mkhan po's defense against the second criticism raised by Grwa phug pa.[131] Grwa phug pa's criticism was made essentially from the perspective of *Phug pa grub rtsis*, and Sum pa Mkhan po looks to focus on explicating the accuracy of *byed rtsis* by using the eclipse at the Buddha's enlightenment, on the one hand, and focus on explaining the problem of *grub rtsis*, on the other. His argument is as follows:

> *ṭik chen gyi lugs gzhir bzhag ste khyed rang dag gis kyang byed rtsis kyi nang nas zhib par bzhed pa ltar gyi yar log gi rtsis byas na chu rta la de'i sa ga'i nya la ri mo 'di lta bu shar bas 'dzin dus dang rgya gar dang bod kyi sa tshigs* (linear note: *sa skya dang rdo rje gdan bar dpag tshad brgyar bshad) bar khyad la man ngag ltar gyi phri snon byas pas 'phags yul dbus su nya de'i tho rangs zla 'dzin dang sangs rgyas tshul gyi mdzad pa ston pa 'grigs la* / [continued below]
>
> ... If being based on the *Great Commentary*, you (*Phug pa* scholars) also perform backward calculation, as is stated exactly within *byed rtsis*, the values appear like this on the full moon day of the month of the *sa ga* in the water-horse year (879 B.C.E.). So, by adding and subtracting eclipse timing and the geographical distance between India and Tibet (it has been said that the distance between Sa skya monastery and Vajrāsana is 100 *dpag tshad*[132]) according to an oral instruction (S. *upadeśa*), the lunar eclipse in the center of the Holy Land on the daybreak of the full moon day coincide with the way of the Buddha's enlightenment shown.

[131] Sum pa Mkhan po (1979: 180b-181a) [= (1992: 544-6)]. For the defense of the third criticism, see Sum pa Mkhan po (1979: 181a ff.) [= (1992: 546ff.)]. I mainly focus on the first and second criticism.

[132] For *dpag tshad*, see Bsam 'grub rgya mtsho (2011: 24).

Sum pa Mkhan po’s Table B.[133]

6		25	1	14	1
1	12	2	39	58	28
40		6	7	58	58
0	72	0	5	5	5
0		12	4	8	8
gza’[134]	*ril cha*	*nyi dhru*	*gza’*[135]	*zla*[136]	*nyi dag*

Sum pa Mkhan po’s Table C.

26	0	14
14	45	15
13	46	46
0	5	5
6	17	17
rtsa	*mgo*[137]	*mjug*

He calculates the value in India on 879/4/15 to defend Mkhas grub’s *byed rtsis*.[138] He thinks that, because the lunar eclipse at the Buddha’s enlightenment occurred in India,

[133] The basis of the calculation in these tables is not identified at present. Nothing is known how he computed these values. When compared with the previous table, the value of *nyi dag* is identical, but that of *gza’ dag* is different. Given the context, the values may be those of *byed rtsis chu rta* (879 B.C.E.)/4/15 at Rdo rje ldan (Vajrāsana), but the calculation method or *man ngag* is difficult to know. It seems that a certain correction was applied to the values in the previous table by *man ngag*. This table clearly evidences that Tibetans were aware of the time difference due to the longitude; better to say the four cardinal points: north, east, south, and west.

[134] *gza’ dhru.*

[135] *gza’ dag.*

[136] *tshes ’khyud zla skar.*

[137] Generally, Rāhu’s head is called *gdong* (*sgra gcan gdong*).

the values should be those in India, and if the eclipse is possible by the values, the accuracy of *byed rtsis* is posited. Because *tshes 'khyud zla skar*[139] (14^{k}58^{q}58'5"8"') and *sgra gcan mjug* (14^{k}15^{q}46'5"17"') are very close in the above table, the lunar eclipse may have occurred (Note that there is no guarantee that an eclipse occurs just by the possibility check). After that, Sum pa Mkhan po uses *Phug pa* scholar Nor bzang rgya mtsho's opinion on *byed rtsis* and divides *byed rtsis* into two[140] to defend Mkhas grub's *byed rtsis*.

> *'di la rje nor bzang bas zhal lung bur*[141] *sngon gyi byed rtsis nyid kyi skabs su dag par 'dod pa'i lo nyis brgya nyer gcig gi rtsis 'phro'i steng nas yar log gi ri mos brtsis na chu rta de dang de'i snga phyi'i 'ga' zhig gi bar du sa ga'i nya'i mtshan mo zla 'dzin ri mo mi 'char la phyis kyi byed rtsis kyi yar log la de shar yang byed rtsis la lo mang bo nas skyon 'byung pas nges pa med ces gsungs pa ni*[142] *zhal lung ma'i mkhas pa lhun rgyam pa'i gsungs dang bstun ched tsam yin gyi / gzhan du na sngon gyi byed rtsis 'ga' zhig rags pas de la de'i ri mo ma shar yang skyon med la / phyis kyi bu ston dang mkhas grub rje dang 'jam dbyangs chos mgon sogs kyis brtsi bar mdzad pa'i byed pa ni me mkha' rgya mtsho la brgya gya gnyis kyis phris pa'i nyis brgya nyer gcig gi'am gzhan phyis kyi rtsis 'phro gang yin kyang don 'dra bas de'i steng nas brtsis pa ni snga ma las rtsis tshul shin tu zhib*

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[138] The way how he produced the *byed rtsis* values in Vajrāsana is not known. It seems that he embraced a certain *man ngag*, but it does not appear in his *ma* (= *Skar nag rtsis kyi snying nor nyung 'dus kun gsal me long*) and *bu* (= *Zla bsil rtsi sbyor dge ldan rtsis gsar*). I hope that someone will be able to clarify this in the future.

[139] For the term, see Janson (2014: 29): "The (true) longitude of the moon at the end of the lunar day (*tshes zhag*)."

[140] According to Sum pa Mkhan po, there are two different *byed rtsis*: *sngon gyi byed rtsis* / *phyis kyi byed rtsis* (= *byed rtsis rnam dag*). It is difficult to identify them. As far as I know, there is no such thing. In conjunction with the terms, Nor bzang rgya mtsho (2002a: 585-8) mentions that the contemporary *byed rtsis* is different from the *byed rtsis* from the *Laghukālacakra*. However, I think that it is not likely what Sum pa Mkhan po meant because Nor bzang rgya mtsho's logic is that the contemporary *byed rtsis* is not correct, being compared with the *byed rtsis* of the *Laghukālacakra*.

[141] I could not identify this in the *bu yig* (= Nor bzang rgya mtsho's 11 texts included in Grwa phug pa (2002)). The quotation does not seem to exist in them.

[142] I cannot identify these contents in Nor bzang rgya mtsho. No such contents exist in his *bu yig* texts.

pas rtsis 'phro de dag gi steng nas yang dag par bris na da ltar 'ang (sic. yang) 'chug med 'byung ba dang / khyad par du 'dir bkod pa'i byed pa'i ri mo ni de las kyang zhib pas zhal lung gi grub rtsis dang rags zhib cher med par ma zad mig skar[143] *dang gza' 'dzin la grub rtsis las kyang lhag cing zhib pas 'di'i steng nas yar log byas pa'i chu rta'i sa ga'i zla 'dzin la 'khrul ba med par nges la /... .* [144]

Here, the statement made by Nor bzang rgya mtsho in a son-text of the *Pad dkar zhal lung* that if [ ] is calculated by the values from the backward calculation on the basis of *rtsis 'phro* of the 221 years, which is asserted to be accurate on the occasion of previous *byed rtsis*, the lunar eclipse does not occur on the full moon day of the month of the *sa ga* in the water-horse year (879 B.C.E.) during several previous and subsequent years, and although [the eclipse] occurs according to backward calculation by later *byed rtsis*, there is no certainty because errors appear from many years in *byed rtsis* in accordance with the learned scholar Grwa phug pa's statement in the *Pad dkar zhal lung*; otherwise, because previous *byed rtsis* is a little rough, the values do not occur, but there is no error, and *byed rtsis* calcuated by later Bu ston and Mkhas grub and Mañjuśrī Chos kyi mgon po is unmistaken also in the present when [it is] calculated correctly on the basis of the *rtsis 'phro* because the calculation is far more accurate than the previous one in the case that [it is] calculated on the basis of the 221 years, which is [the result of] subtracting 182 years from 403 years (*me mkha' rgya mtsho*), or moreover, because later *rtsis 'phro*, whatever, has the same meaning. Especially, because *byed rtsis* values written here are more accurate than that, it is not only not much different in terms of a rough and subtle level, when being compared with *grub rtsis* in the *Pad dkar zhal lung*, but also is superior to *grub rtsis* in terms of observation and eclipse. Because of that, in the case of the lunar eclipse of the month of the *sa ga* in the water-horse year (879 B.C.E.) calculated backward on the basis of the *byed rtsis*, there is certainly no mistake. ...

Sum pa Mkhan po's intention is clear, but his use of Nor bzang rgya mtsho's opinion on *byed rtsis* may be arbitrary. He does not present proper bases to support his opinion on Nor bzang rgya mtsho's intention. Also, he commits a fallacy of *petitio principii*. (The truth of the conclusion is assumed by the premises): he should prove the accuracy of *byed rtsis*, but it was already presupposed.

[143] *mig skar* : observed star (*skar ma*). In most cases, it looks to be fine to render it as observation.

[144] Sum pa Mkhan po (1979: 180b) [= (1992: 544-5)].

Next, he investigates whether or not the lunar eclipse occurs by *byed rtsis* in the case of 927 B.C.E. (*shing rta*)/4/15, which was given by *Phug pa* as the date of the lunar eclipse at the Buddha's enlightenment.

> *khyed dag gis rgyal bu gzhon nu don 'grub shing rta'i sa ga'i nya las sangs rgyas par bzhed pa'i skabs 'tshol sa'i sgrub byed yang dag gi gtan tshig ni de nub gza' 'dzin gyi ri mo shar ba dang 'grigs pa'i phyir zhes gsung rgyu yin kyang ma grub pa'i rtags ltar snang yin nam snyam ste / de'i rgyu mtshan ni zhal lung grub rtsis ltar la der gza' 'dzin ri mo shar yang byed rtsis rnam dag la ri mo sbyang lhag 'di shin tu nyung bas de nub zla 'dzin med do /*[145]

> I think that it is apparently an unestablished proof even if the proper argument of the basis of the investigation when you (*Phug pa* scholars) say that prince Siddhārta attained enlightenment on the full moon day of the month of *sa ga* in the wood-horse year (927 B.C.E.) should be said that it is in order to accord with the occurrence of the value of the eclipse that night. The reason is that the eclipse took place according to *grub rtsis* in the *Pad dkar zhal lung*,[146] but, because the remainder from the subtraction is very small in the case of the acurate *byed rtsis*, no eclipse occurred that night.

Sum pa Mkhan po's Table D. [147]

3	16	2	16	0
55	27	57	29	1
36	46	46	36	50
5	0	0	3	2
2	9	9	3	5
				16
gza'[148]	*'khyud*[149]	*nyi*[150]	*gdong*	*lhag*[151]

[145] Sum pa Mkhan po (1979: 180b-181a) [= (1992: 545-6)].

[146] For the value, see above note 94.

[147] This table is *byed rtsis* values of 927 B.C.E. (*shing rta*)/4/15, which *Phug pa* scholars claim to be the day of the Buddha's enlightenment.

[148] *gza' dag.*

He says that the remainder ($0^{k}1^{q}$50'2"5"'16"") is too small for the lunar eclipse to occur in the case of *byed rtsis*.[152] I do not know how to make sense of this, but it is certain that he tries to prove that the lunar eclipse, which occurs according to *Phug pa*'s logic, does not occur in the case of *byed rtsis*. Ensuingly, he adds a different logic for saving *byed rtsis*.

> *de ltar na yang gal te byed rtsis la ma shar yang sgrub (sic.) rtsis la gza' 'dzin yod pa'i ri mo shar bas chog zer na / de yang mi 'thad de / de nub byed sgrub (sic.) ci rigs la gza' 'dzin ri mo shar tsam gyis mi chog par nges par zla 'dzin mthong rgyu zhig yod dgos la / de ltar na sgrub rtsis la de ltar 'dzin pa'i ri mo shar yang nges pa med cing byed rtsis rnam dag la de shar na nges par 'dzin pa da ltar yang mngon sum gyis 'grub pa dang / der ma zad zhal lung rjes 'brang dpyod ldan rtsis rig la byang ba'i ldum po don 'grub dbang rgyal dang gnas lnga la mkhas pa'i sangs rgyas rgya mtsho sogs kyis kyang zla 'dzin yod med byed rtsis dang dus tshod gtso bor grub rtsis thig 'ongs zhes pa don la'ang gnas so /*[153]

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149 *tshes 'khyud zla skar.*

150 *nyi dag.*

151 *lhag ma*. Here, *sgra gcan gdong* – *tshes 'khyud zla skar* = $16^{k}29^{q}$36'3"3"' (27/60/60/6/23) – $16^{k}27^{q}$46'0"9"'(27/60/60/6/13) = $16^{k}29^{q}$36'3"1"'6"" – $16^{k}27^{q}$46'0"9"' = $0^{k}1^{q}$50'2"5"'16"" (27/60/60/6/13/23).

152 The mention of a similar kind is as follows: Ku sri skyabs (1979: 37a): "In general, *chu tshod* is asserted to be small [for the occurrence of eclipse], but the two (= *skar ma* and *chu tshod*) are 0 (= the value of the difference between *tshes 'khyud zla skar* and *sgra gcan gdong* or *mjug* is too small), an eclipse does not occur. The *chu tshod* value (= the difference between *tshes 'khyud zla skar* and *sgra gcan gdong* or *mjug*) in the case of lunar eclipse is [comparatively] bigger [than the solar eclipse], but if [the value] is more than 58 in the case of *gdong 'dzin* (eclipse by *sgra gcan gdong*), and [the value] is over 55 in the case of *mjug* (*mjug 'dzin*. eclipse by *sgra gcan mjug*), an eclipse is not seen." (*spyir ni chu tshod nyung bzhed kyang / gnyis ka stongs* (*sic.* read *stong*) *na 'dzin mi 'gyur / zla 'dzin chu tshod mang bzhed kyang / gdong 'dzin klu dbang (58) lhag pa dang / mjug la 'byung mda' (55) bsgral* (*sic.* read *bsgril*) *ba na / mthong bar gyur pa ma yin no /*). Sum pa Mkhan po and Ku sri skyabs's knowledge seems to be (or highly possibly) related to the empirical knowledge accumulated at that time.

153 Sum pa Mkhan po (1979: 181a) [= (1992: 546)].

> Nevertheless, if you allege that it is fine because even if [the values of the lunar eclipse] do not appear in *byed rtsis*, the values of the lunar eclipse rise in *grub rtsis*, it is also unacceptable. It is not sufficient just by the occurrence of the values of the eclipse in terms of *byed rtsis*, *grub rtsis*, whatever, that night. The lunar eclipse should be certainly proved by real observation. If it is the case, even if the values of an eclipse such as those according to *grub rtsis*, there is no certainty, and surely being an eclipse, if it appears in the accurate *byed rtsis*, is established by direct perception also in the present. In addition to that, the statements made also by sagacious Ldum po Don 'grub dbang rgyal[154] who is skilled in astronomy, the proponent of the *Pad dkar zhal lung*, and the Sde srid who is versed in five sciences, etc., that, *byed rtsis*, is accurate for deciding the occurrence of lunar eclipse and in the case of timing, mainly *grub rtsis* is accurate according with how things are.

His logic, as noted in the above passage, aims at the defense against Grwa phug pa's second criticism. His aim is twofold as before: explaining the accuracy of *byed rtsis* and clarifying some problems in *grub rtsis* in terms of eclipse calculation. For that purpose, he raises the issue of observation. He claims that real observation is crucial and *byed rtsis* calculation results reflect real phenomena of an eclipse better than those of *grub rtsis*.[155]

[154] Ldum bu Don grub dbang rgyal (active in 17th c.) is one of the excellent *Phug pa* scholars being contemporary with Dalai lama V. Samten Karmay (2014: 377): "Palgon Trinle had taught them (the instructions taught by the *Phug* tradition) to Lord Palseng. Lachen Trashi passed on this tradition to Dondrub Wanggyal, the foremost learned man in this field. So I listened to the latter about it in full detail." Also, see Tshul khrims chos 'byor (1982: 29). Tshul khrims rgyal mtshan (1986: 361): "Later, many scholars such as Gzhon nu don grub, the father of Zur chen chos dbyings rang grol (1604-1669) at Smin grol gling, Ldum po (bu) Don grub dbang rgyal, expert in astronomy from Lho kha gra nang, and Lu 'go bla mkhyen Ngag dbang, etc. appeared." (*rjes su smin gling zur chen chos dbyings rang grol gyi yab gzhon nu don grub dang / rtsis rig smra dbang lho kha gra nang gi ldum po don grub dbang rgyal dang / lu 'go bla mkhyen ngag dbang sogs phug lugs kyi rjes 'dzin mkhas shing mang ba byon te …*). For Ldum bu (po), see Smith (2001: 243): "There is absolutely no doubt that Ldum bu was the actual author of the *Vaiḍūrya dkar po* and probably several other astrological works assigned to the authorship of the Sde srid." For van der Kuijp's legitimate counterview, see van der Kuijp (2013: 135, n. 45). For Lu 'go Ngag dbang, see below note 422.

[155] Regardless of the real calculation practice that was being used in Sum pa Mkhan po's time for the accuracy of elipse calculation, his logic is not persuasive from the perspective of the lunar eclipse at the Buddha's enlightenment. How can he observe the lunar eclipse at the Buddha's eclipse, which happend long time ago? How can he guarantee that *byed rtsis* also worked better than *grub rtsis* at the time of the Buddha?

His stance giving credence to *byed rtsis* in terms of eclipse calculation is also dramatically read in the following.

> *yang zhal lung grub rtsis pas gzhan bu ston mkhas grub sogs kyi byed rtsis nyi zla sgra gcan (sic.) gza' lnga gang gi skabs su'ang 'gros mi thig zer mod kyang grub rtsis de ltar na mig skar dang 'grigs pa nyung zhing khyad par du gling 'di'i mi kun gyis mngon sum mthong rgyu'i gza' 'dzin kyang thig pa nyung ste / dper na rab drag sa yos lnga ba'i zla 'dzin byed rtsis la med kyang zhal lung grub rtsis la mkhas pa du mas rags zhib gnyis ka ltar brtsis te yod ces lha sa se 'bras sogs su sgo yig sbyar kyang ma byung zhes sngon gyi myong byang na gsal ltar deng sang yang grub rtsis des mi thig pa mang du 'byung bzhin pa'o /*[156]
>
> Furthermore, although *grub rtsis pa*, based upon the *Pad dkar zhal lung*, indeed alleges that *byed rtsis* of others such as Bu ston, Mkhas grub, etc., is not accurate in whatever occasions of sun, moon, Rāhu, five planets are concerned, there are not many cases that are in accordance with observation, and especially, even the eclipse that is to be seen by all people here is far from accurate, according to *grub rtsis*. For example, as clarified in the previous *myong byang* (note on personal experience/observation) mentioning (the instance) that no lunar eclipse was predicted in the fifth month, the earth-hare year of the 11th *rab byung* (*rab drag sa yos*/ 1639 C.E.) in *byed rtsis*, but in the case of *grub rtsis* of the *Pad dkar zhal lung*, many *grub rtsis* scholars calculated according to the two methods, i.e., rough and subtle *grub rtsis*, predicted that there would be eclipse and put up the *sgo yig* (posters)[157] at the monasteries of Se ra, 'Bras spungs, etc., in Lhasa, but did not occur, inaccurate occasions happen many times according to *grub rtsis* nowadays, too.

It is known from the above passage that the reason why Sum pa Mkhan po criticizes *Phug pa grub rtsis* and defends *byed rtsis*, including Bu ston, Mkhas grub, etc. is that eclipse calculations based upon the latter is more accurate than those based upon the former. The fact that eclipse calculations by the former do not match up with real phenomena does not merely mean that the calculation system of the former is flawed. The

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156 Sum pa Mkhan po (1979: 184a) [= (1992: 556)].

157 This way of publicizing the calculation results to check their accuracy was customary in Tibet. See also Bstan 'dzin dpal 'byor (1987: 285) [= Bstan 'dzin dpal 'byor (1988: 238)].

fundamental stratum also lies in *bstan rtsis*: if an eclipse is not accurately predicted, how can the *bstan rtsis* based upon the lunar eclipse at the Buddha's enlightenment be justified?

All in all, it is speculated that the essential reason why Sum pa Mkhan po refuses *Phug pa*'s *bstan rtsis* and accepts *byed rtsis*'s *bstan rtsis* is due to the correspondence between calculations and real phenomena in the case of the latter. Ultimately, his criticism toward Grwa phug pa is closely tied to the *bstan rtsis* in the *Dga' ldan rtsis gsar* with new *rtsis 'phro*-s and *stong chen'das lo* where eclipse calculation is central and pivotal.[158]

RGYA RTSIS SUBSUMED UNDER RELIGIOUS FRAME

In Tshe tan Zhabs drung (2007b) written in the late winter of 1949 C.E. or early winter of 1950 C.E. ("winter in the earth-female-ox year". T. *sa mo glang gi lo'i dgun*), Tshe tan zhabs drung follows the *bstan rtsis* of the *Phug* system, not that of *byed rtsis*. He has the same logic as used by his predecessors: *yar* (*s*)*log gi rtsis*.[159]

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[158] For this information, *see* chapter 4.

[159] Tshe tan Zhabs drung (2007: 10): "The root quantity of the *Kālacakra* tradition established by *Phug pa* by backward calculation, regarding the lunar eclipse when the Buddha attained enlightenment, is not only unmistaken, it is also because the Buddha's elapsed years are seen more accurate than others also when I calculated backwardly the root quantity by *rgya rtsis* (= *Mā yang rgya rtsis*)." (*ston pa sangs rgyas pa'i dus kyi zla 'dzin la dus 'khor lugs kyi dhru wa yar slog phug pas bkod pa de gtsigs par ma zad / bdag gis rgya rtsis steng nas dhru wa yar slog bris pa'ang ston pa'i 'das lo gzhan las gtsigs par mthong ba'i dbang gis yin no /*). My interim rendering for "*gtsigs pa*" is "unmistaken/ accurate."

He applied the *skar rtsis* religious concept and frame of *bstan rtsis* to the *Mā yang rgya rtsis*, which derived from Qing Chinese system for eclipse calculation around the 18th/19th century.[160] By using Ser chen (1861), one of the *Mā yang rgya rtsis* texts, he verified the lunar eclipse at 927 B.C.E. (*shing rta*)/4/15, which is the date given by *Phug pa*. His calculation is as follows: *lo dag pa* = 837 (1027 C.E. ~ 1863 C.E.[161]) + 403 (tenth and eleventh Rigs ldan-s (S. Kalki) 624 C.E. ~ 1026 C.E.) + 1500 (877 B.C.E. ~ 623 C.E.) + 4 (Sucandra's years 881 B.C.E ~ 878 B.C.E.) + 46 (927 B.C.E (the year of the Buddha's enlightenment according to the *Phug* system) ~ 882 B.C.E.) = 2790 years.[162] *Zla dag* = 34510, and *mda' ro lhag ma* = 20. The calculational results are as follows:[163] The total eclipse (T. *ril 'dzin*) occurs. Timing is substracted from the standard Beijing time. The value of half-duration is 1 *dus* 50 *thun* 23 *srang* (24/60/60).[164] The following table derives from the value.

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[160] For the *rgya rtsis* (*Mā yang rgya rtsis*) calculation, see Tshe tan Zhabs drung (2007b: 403-13).

[161] 1863 C.E. is *chu phag* which is the last (= 60th) year according to Chinese calendar / *Rgya rtsis*. In "*shing bya'i sngar lo chu phag nas*" (2007b: 405), *shing bya* should be *shing byi*. Also it should be noted that Ser chen (1861)'s epoch is 1863/12/0 according to *grub rtsis*. It is speculated that Tshe tan Zhabs drung used Ser chen (1861), not Mkhyen rab nor bu (1943) [= the version that Mkhyen rab nor bu changed Ser chen (1861)'s epoch (= 1863/12/0) into 1926/12/0].

[162] Tshe tan Zhabs drung (2007b: 405).

[163] Tshe tan Zhabs drung (2007b: 406ff. especially, 410-2).

[164] Half duration = *'dzin rdzogs mkho dus* − *'dzin mgo rtsom dus* = *grol zin dus* − *'dzin rdzogs mkho dus*. The incorrect value 1 *dus* 50 *thun* 43 *srang* (for the correct one, see above) is given in Tshe tan Zhabs drung (2007b: 410). The *'dzin gtong yun tshod* is given as a term to denote half-duration, but this is incorrect. It means a duration of an eclipse between the beginning (T. *'dzin 'go* / *'dzin mgo*. first contact) and the end

Table 5.

Tshe tan Zhabs drung's term[165]	Beijing time	Amdo time	Lhasa time
first contact (*'dzin mgo rtsom dus*)[166]	4 *dus* 12 *thun* 18 *srang*	3 *dus* 22 *thun* 18 *srang*	3 *dus* 0 *thun* 8 *srang*
second contact (*bsgribs ma thag dus*)[167]	5 *dus* 17 *thun* 2 *srang* [168]	4 *dus* 27 *thun* 2 *srang* [169]	4 *dus* 5 *thun* 2 *srang*

(T. *'dzin gtong* / *btang zin*. last contact). In this case, it is 3/40/46. The units *dus*, *thun*, and *srang* are the same with modern units: 1 hour (T. *dus*) = 60 minutes (T. *thun* / *phun* < 分), 1 minute = 60 seconds (T. *srang*). It is because the *Mā yang rgya rtsis* is based upon the Chinese *Lixiang kaocheng* / *Lixiang kaocheng houbian* system which is / are the Chinese versions of Western Jesuit astronomy. For more information, see chapter 3. There are many typographical errors in the computerized Tshe tan Zhabs drung (2007b), as Tibetan astronomical texts are usually so, regardless of being ancient manuscripts/block prints or modern computer inputed version.

165 Roughly, a total eclipse is composed of five phases: first contact (T. *'dzin 'go / 'dzin mgo*. (*Mā yang rgya rtsis* term). Ch. *chukui* 初虧), second contact: beginning of total eclipse (T. *sgrib ma thag*. Ch. *shiji* 食既), mid-eclipse (mid-totality. T. *'dzin rdzogs*. Ch. *shishen* 食甚), third contact: end of total eclipse (T. *mtha' nas gso.* Ch. *shengguang* 生光), and fourth (last) contact: end of the whole process (T. *'dzin gtong* / *btang zin*. Ch. *fuyuan* 复圆). A partial eclipse is composed of three contacts: first contact (T. *'dzin 'go / 'dzin mgo*. Ch. *chukui*), mid-eclipse (T. *'dzin rdzogs.* Ch. *shishen*), last contact (T. *'dzin gtong* / *btang zin*. Ch. *fuyuan*). Mongolian terms were used in Mongolian *Shixianli* (時憲曆) in Qing China: I could find following terms in Jin (1992: 42): first contact: *egüsgen γarumui*, second contact in total eclipse: *bariǰu ketüremüi*, last contact: *dakin dügüreng*. Because I have not secured the Monolgian *Shixianli*, I cannot present the terms in their entirety.

166 The *Mā yang rgya rtsis* term (see chapter 4) is *'dzin ma thag* (*'dzin 'go*) *gi dus tshod*, which is a different term from Tshe tan Zhabs drung (2007b: 410).

167 The *Mā yang rgya rtsis* term is *sgrib ma thag gi dus tshod* which is basically the same. See Tshe tan Zhabs drung (2007b: 411).

168 The incorrect value 5 *dus* 10 *thun* 7 *srang* is given in Tshe tan Zhabs drung (2007b: 411).

169 The incorrect value 4 *dus* 77 *thun* 2 *srang* is given in Tshe tan Zhabs drung (2007b: 411).

Table 5 (continued)

mid-eclipse (*'dzin rdzogs mkho dus*)[170]	6 *dus* 2 *thun* 41 *srang*	5 *dus* 12 *thun* 41 *srang*[171]	4 *dus* 50 *thun* 41 *srang*
third contact (*mtha' nas gso dus*)[172]	6 *dus* 48 *thun* 20 *srang*	5 *dus* 58 *thun* 20 *srang*	5 *dus* 36 *thun* 20 *srang*
fourth (last) contact (*grol zin dus*)[173]	7 *dus* 53 *thun* 4 *srang*	7 *dus* 3 *thun* 4 *srang*	6 *dus* 41 *thun* 4 *srang*

The time difference between Beijing and Amdo is assumed to be 50 minutes, and that between Amdo and Lhasa 22 minutes (1 hour and 12 minutes in total).[174]

Taken together, it has been crucial in the Tibetan astronomers' rationalization of *bstan rtsis*-s to make the different Indic traditions and texts, i.e. the *Kālacakra* and some

[170] The *Mā yang rgya rtsis* term is *'dzin rdzogs kyi mkho ba'i dus tshod*, which is the same with Tshe tan Zhabs drung (2007b: 410).

[171] The incorrect value 5 *dus* 14 *thun* 41 *srang* is given in Tshe tan Zhabs drung (2007b: 410).

[172] The *Mā yang rgya rtsis* term is *mtha' nas gso dus*, which is the same with Tshe tan Zhabs drung (2007b: 412).

[173] The *Mā yang rgya rtsis* term is *btang zin dus tshod*, which is a different term from Tshe tan Zhabs drung (2007b: 411).

[174] In the *Mā yang rgya rtsis* tradition, the calculated timing accords with Beijing time. Then, subtractions are made to calculate Amdo and Lhasa time as above. It seems that there have existed a few different values applied according to Huang and Chen (1987a). According to Huang and Chen (1987a: 412), the above method accords with that of Drung yig Thub bstan rgya mtsho's (active in the 19th c.) *Ma ha tsi na'i rang lugs 'ba' zhig las 'ongs pa'i zla nyi sgrib rtsis 'jam dbyangs 'dzum zer*. This text is not available to me. For the time differences indicated in the *Mā yang rgya rtsis*, see chapter 4.

Buddhist texts, compatible on the basis of the *Kālacakra* calculation method.[175] Thereby, the Tibetan chronology based upon Buddhism (*bstan rtsis*) has acquired the new horizon, which was unprecedented in India. In its apex, eclipse calculation exists. It verifies the accuracy of a system on an astronomical level and simultaneously functions as the most pivotal criterium for the various *bstan rtsis*-s on a Buddhist level. It is a foundation stone on which *skar rtsis*, whose essential part is *bstan rtsis* in that the accuracy of *bstan rtsis* is a synonym for the accuracy of an astronomical system, stands firm. In that sense, many efforts to produce more accurate eclipse calculations have been made in Tibet. The ideas of and approaches to the issue of eclipse calculation were not restricted to *skar rtsis*. It is assumed that the *Mā yang rgya rtsis* introduced to Tibet from Qing China can be understood from that perspective, given Tshe tan Zhabs drung (2007b). In other words, in both *skar rtsis* and the *Mā yang rgya rtsis*, the notions on eclipse calculation are common on the astronomical and religious level.

[175] I have no information on whether the historical approach, which is based upon the concept that Buddhist texts have been created and formed during different time periods, has been made by Tibetan astronomers when they try to reconcile the chronologically different texts.

CHAPTER TWO

THE RITE OF CONFESSION (S. *POṢADHA* / T. *GSO SBYONG*)

1. *GSO SBYONG* DATE AND *ZHAG MI THUB* (S. *ŪNARĀTRA*)

Time measurement is closely tied to the observance of *Vinaya*, Buddhist disciplinary regulations. The rite of *poṣadha*[176] (P. *uposatha*, S. *poṣadha* / *upavasatha*, T. *gso sbyong*) epitomizes it.[177] In it, monks confess offenses and chant the *Prātimokṣa sūtra*. The canonical basis of the ceremony is the *Poṣadhavastu* (T. *gso sbyong gi gzhi*) in the *Vinayavastu* (T. *'Dul ba gzhi*).[178] Hu-von Hinüber presents the following three categories in relation to the way of the performance of the *poṣadha*: date, number of participants, and

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[176] For general information on the rite, see Childers (1875: 535-6), Upasak (1975: 52-4), *Bod rgya tshig mdzod chen mo* (2000: 3029), Cabezón (2010: 2).

[177] For a general understanding of Buddhist ritual, see Kieffer-Pülz (2000). Time measurement in *vinaya* texts in general and with a focus on the *'Dul ba gzhung dam pa* (S. *Vinayauttaragrantha*) is found in Schopen (1998: 157-79, especially 176). For the location of the *'Dul ba gzhung dam pa* in the different xylographs of *Bka' 'gyur*, see Prebish (1994: 98-9).

[178] Textual bases: Banerjee1 (1957: 187-95), Hu-von Hinüber (1994: 56-8). For Tibetan editions, see Hu-von Hinüber (1994: 65-6). For the location in *P.* and *D. Bka' 'gyur*, see Prebish (1994: 93).

contents.[179] In this manuscript, the first category, date, is the main concern.[180]

The three foundations of *Vinaya* (*'Dul ba gzhi gsum*) are "the ceremony for restoring monastic vows (T. *gso sbyong*), the rules for the rainy season retreat (S. *varṣa*, T. *dbyar gnas*), and the ceremony at its end for lifting these rules (S. *pravāraṇā*, T. *dgag dbye*)."[181]

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[179] See Hu-von Hinüber (1994: 22). And Hu-von Hinüber (1994: 9): there are two kinds of *poṣadha*: one for lay people; the other for *saṃgha*. I focus on the latter, especially the date of the rite of *poṣadha*.

[180] For the second category, following Indian exemplary occasion is seen in a commentary written by Mtsho sna ba Shes rab bzang po (birth: 13th c.). According to Schuh (1973a: 8-9, n. 30), Tshe mchog gling Yongs 'dzin Ye shes rgyal mtshan's (1713–1793) *Rgyal bstan mdzes pa'i rgyan mchog phul byung nor bu'i phreng ba* includes a short biography of him. Mtsho sna ba (2013: 72-3): "If it is the 15th lunar day for resident monks (S. *āvāsika/ naivāsika*. T. *gnyug mar gnas pa*) and it is the 14th or the 16th lunar day for non-resident monks (S. *āgantuka*. T. *glo bur du lhags pa*), ***one should follow the majority for the timing* [*of the gso sbyong ritual*]**. … ***If*** the number of resident monks and that of non-resident monks ***are the same***, *lam mthun pa* (?) such as lunar day numbers ***is of resident monks***. … Furthermore, if resident monks performed *gso sbyong* and then, more non-resident monks say that it is the 15th for the next day the 16th, resident monks should also definitely perform *gso sbyong*. When the monks, whose one day passed after having performed *gso sbyong* on the 15th day in other places, suddenly come, the non-resident monks should definitely carry out *gso sbyong* if the resident monks whose number is the same with or more than the guest monks say that today is the 15th." (*gal te gnyug mar gnas pa rnams kyi tshes bco lnga yin la glo bur du lhags pa rnams kyi tshes bcu bzhi'am tshes bcu drug yin na /* ***dus kyi phyir ni ches mang ba rnams kyi rjes su 'jug par bya ba nyid yin no*** */ … / gnyug mar gnas pa'i dge slong gi grangs dang glo bur lhags pa'i dge slong gi grangs* ***mnyam pa nyid yin na*** *tshes grangs la sogs pa lam mthun pa de* ***gnyug mar gnas pa rnams kyi'o*** */ … de'ang gnyug mar gnas pas tshes bco lnga'i gso sbyong byas nas sang tshes bcu drug la glo bur du lhags pa ches mang po dag de ring tshes bco lnga'i zhes zer na gnyug mar gnas pas kyang gso sbyong nges par bya dgos so / gnas gzhan du gso sbyong bco lnga pa byas nas zhag gcig lon pa'i dge slong dag glo bur du 'ongs na glo bur ba dang grangs mnyam pa'am grangs mang ba'i gnyug mar gnas pa rnams de ring tshes bco lnga'o zhes zer na glo bur du 'ongs pas kyang gso sbyong nges par bya dgos te … /*). In the above quotations, bold and italic fonts are passages from Guṇaprabha's (Yon tan 'od) *'Dul ba mdo* (*Vinabasūtra*). See *Bstan 'gyur Dpe bsdur ma*, Vol. 88: 984. For the introduction of the *'Dul ba mdo* and its location in *Bstan 'gyur*, see Prebish (1994: 103-4). Specifically for this instance, see Hu-von Hinüber (1994: 466-7). And see Kieffer-Pülz (2000: 383). For Guṇaprabha's life and significance in Indian and Tibetan Vinaya tradition, see Nietupski (1993: 226-74). For the terms, *āvāsika*, *naivāsika,* and *āgantuka*, see Hu-von Hinüber (1994: *passim*, especially 346 ff). For her explanation, see Hu-von Hinüber (1994: 191-2). For the difference between *āvāsika* and *naivāsika*, see Silk (2008: 150-1). And for the rationale of the performances of *gso sbyong* according to the difference of the numbers of resident monks and guest monks explained in the above passage, see Gangopadhyay (1991: 42-5). Last, as for the third category contents, see Hu-von Hinüber (1994: 22).

[181] Cabezón (2010: 32, n. 28): "the three basic monastic rites (*gzhi gsum cho ga*): the rite of confession (*gso sbyong*), the rite for entering into the rainy season retreat (*dbyar gnas*), and the rite for exiting from the rainy season retreat (*dgag dbye*)."

The practice of *gso sbyong* in Tibet is based upon the *Mūlasarvāstivāda Vinaya*, which is the only *Vinaya* translated into Tibetan in the beginning of the 9th century.[182]

THE DATE OF *GSO SBYONG* AND ITS RATIONALE, *ZHAG MI THUB*

In the case of *gso sbyong*, following two issues may be raised in conjunction with astronomy: deciding the date of *gso sbyong* and its relationship to eclipse. Firstly, as for the date in the *gso sbyong*, there are two occasions: *cātuddasī* (S. *cāturdaśī*) and *paṇṇarasī* (S. *pañcadasī*), i.e. the 14th day (*gso sbyong bcu bzhi pa*) and the 15th day *gso sbyong* (*gso sbyong bco lnga pa*) on a lunar fortnight basis respectively.[183] Then, when is it held on the 14th? When the 15th? The following passage by 'Jam dbyangs bzhad pa I (1648–1721/1722) is a good summary of the *gso sbyong* dates.

> *'dir dus 'brel kyi gso sbyong nyer bzhi nges can yod de / lo la zla bshol med dus zla ba bcu gnyis yod cing / zla ba re re'i yar ngo dang mar ngo la gso sbyong re re yod pa'i phyir te / rtsa bar / zla ba phyed phyed kyi tshes bco lnga la'o / zhes dang* [184] */ dge slong gi lo dri bar / gso sbyong du yod / nyi*

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[182] For the Tibetan *Mūlasarvāstivāda Vinaya*, see Willemen, Dessein, and Cox (1998: 85-9), Prebish (1994: 84-113).

[183] Upasak (1975: 53). For the fortnightly 14th or 15th day as the observance day in the *Prātimokṣa sūtra* of the *Mūlasarvāstivādins* (Tibetan tradition), see Prebish (1975: 46, 49). Especially, see Vogel (1997: especially 687).

[184] See Guṇaprabha's auto-commentary to the *'Dul ba'i mdo* (*Vinayasūtra*), *'Dul ba'i mdo'i 'grel pa mngon par brjod pa rang gi rnam par bshad pa* (S. *Vinayasūtravṛttyabhidhānasvavyākhyāna*); *Bstan 'gyur dpe bsdur ma*, vol. 89: 959.

shu rtsa bzhi ste / dgun zla 'bring po dang / dpyid zla ra ba dang tha chung / dbyar zla 'bring po dang / ston zla ra ba dang / tha chung rnams kyi mar gyi ngo'i gso sbyong ni bcu bzhi pa'o / lhag ma ni bco lnga pa'o / zhes gsungs pa'i phyir /[185] *dus 'brel gyi sgo sbyong bcu bzhi dang bco lnga*

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[185] Atiśa Dīpaṃkaraśrījñāna (982-1054), *Dge slong gi dang po'i lo dri ba* (S. *Bhikṣuvarṣāgrapṛcchā*), *Bstan 'gyur dpe bsdur ma,* vol. 93: 922. The division of season may not be simple: first, for the Tibetan division, see Lcang skya III et al. (1982: 52-3), Lcang skya III et al. (2002: 1181), Schuh (2008: 216, 220): spring (*dpyid*)/ summer (*dbyar*)/ autumn (*ston*)/ winter (*dgun*). Second, for the Indian six seasons translated into Tibetan from Indian Buddhist texts, see Ishihama and Fukuda (1989: 384-5) and Sárközi and Szerb (1995: 543-4): spring (S. *vasanta* / T. *dpyid* / [ML] *qabur* / [MT] *qabur*), summer (S. *grīṣma* / T. *so ga* / [ML] *qabur* / [MT] *degjiküi*), monsoon (S. *varṣā* / T. *dbyar* / [ML] *ǰun* / [MT] *ǰun*), autumn (S. *śarat* / T. *ston* / [ML] *namur* / [MT] *namur*), winter (S. *hemanta* / T. *dgun* / [ML] *ebül* / [MT] *ebül*), late winter (S. *śiśira / T. dgun smad* / [ML] *ebül-ün ecüs* / [MT] *ebül-ün adaγ*). For the context of the two different divisions, see Vogel (1964: 229-30), Vogel (1971: 302-3). The following table reflect the former, viz, the Tibetan system. Ishihama and Fukuda (1989: 384-5) and Sárközi and Szerb (1995: 543-4) introduce the both.

Lcang skya III et al. (2002: 1181)		Ishihama and Fukuda (1989: 384-5)			
ra ba	*eki*	**S. *phālguna* T. *dpyid zla ra ba* (T. *dbo*)** [ML] *qabur-un ekin sar-a* [MT] *qabur-un ekin utarabalaguni sar-a*	S. *jyeṣṭha* T. *dbyar zla ra ba* [ML] *ǰun-u ekin sar-a* [MT] *ǰun-un ekin sir-a yin sar-a*	**S. *bhādrapada* T. *ston zla ra ba* (T. *khrums stod*)** [ML] *namur-un ekin sar-a* [MT] *namur-un ekin utarabhadirabad sar-a*	S. *mṛgaśīrṣa* T. *dgun zla ra ba* [ML] *ebül-ün ekin sar-a* [MT] *ebül-ün ekin margaswr sar-a*
'bring po	*dumdadu*	S. *caitra* T. *dpyid zla 'bring po* [ML] *qabur-un dumda sar-a* [MT] *qabur-un dumdadu cayitur sar-a*	**S. *āṣāḍha* T. *dbyar zla 'bring po* (T. *chu stod*)** [ML] *ǰun-u dumda sar-a* [MT] *ǰun-u dumdadu burinsad sar-a*	S. *aśvini* T. *ston zla 'bring po* [ML] *namur-un dumda sar-a* [MT] *namur-un dumdadu aśovani sar-a*	**S. *pauṣa / puṣya* T. *dgun zla 'bring po* (T. *rgyal*)** [ML] *ebül-ün dumda sar-a* [MT] *ebül-ün dumdadu bös sar-a*
tha chung	*adaγ*	**S. *vaiśākha* T. *dpyid zla tha chung* (T. *sa ga*)** [ML] *qabur-un ecüs sar-a* [MT] *qabur-un ecüs śośaγ sar-a*	S. *śrāvaṇa* T. *dbyar zla tha chung* [ML] *ǰun-u ecüs sar-a* [MT] *ǰun-u ecüsen abitsi sar-a*	**S. *kārttika* T. *ston zla tha chung* (T. *smin drug*)** [ML] *namur-un ecüs sar-a* [MT] *namur-un ecüs kirtik sar-a*	S. *māgha* T. *dgun zla tha chung* [ML] *ebül-ün ecüs sar-a* [MT] *ebül-ün ecüs mag sar-a*

The Mongolian terms in the above table may be misleading: first, the *Merged γarqu-yin oron* renders *tha chung* as *adaγ*; meanwhile, the Mongolian *Mahāvyutpatti*s render it as *ecüs*, which is not a problem in itself, but the rendering in the latter cause a problem in the following way: for the translation of *dgun smad*, which is one of the seasons based upon the Indian system, the Mongolian *Mahāvyutpatti*s still use the same terms, *ecüs* or *adaγ*, as seen above. As a result, it is difficult to tell the Tibetan system from the Indian system just by the Mongolian renderings. Going back to the statement by Atiśa in the above quotation, the boldic font in the above table indicates the month in which *gso sbyong* is performed on the 14th day. The dates specified by Atiśa are identical with Vogel (1997: 687) presenting those of the Indian *Mūlasarvāstivāda* tradition, which is the only vinaya tradition introduced in Tibet. Also see Klong rdol bla ma Ngag dbang blo bzang's (1719–1794) following table with a focus on boldic font in Klong rdol bla ma (1985: 50-1).

The way how *nag rtsis pa* (Tibetan *nag rtsis* astrologers) placed the beginning of the year before the calculations of Gtsang chung Chos grags rgya mtsho, Phug pa Lhun grub rgya mtsho, and Mkhas grub Nor bzang rgya mtsho, and the Sde srid Sangs rgyas rgya mtsho, etc. spread. (*rgya mtsho rnam gsum dang sangs rgyas rgya mtsho sogs kyi rtsis ma dar ba'i snga rol nas nag rtsis pas lo mgo 'dzin tshul*)
stag gi zla ba / ***dpyid zla ra ba / gso sbyong bcu bzhi pa***
yos kyi zla ba / dpyid zla 'bring po
'brug gi zla ba / ***dpyid zla tha chung / gso sbyong bcu bzhi pa***
sbrul gi zla ba / dbyar zla ra ba
rta'i zla ba / ***dbyar zla 'bring po / gso sbyong bcu bzhi pa***
lug gi zla ba / dbyar zla tha chung
spre'u zla ba / ***ston zla ra ba / gso sbyong bcu bzhi pa***
bya'i zla ba / ston zla 'bring po
khyi'i zla ba / ***ston zla tha chung / gso sbyong bcu bzhi pa***
phag gi zla ba / dgun zla ra ba /
byi ba'i zla ba / ***dgun zla 'bring po / gso sbyong bcu bzhi pa***
glang gi zla ba / dgun zla tha chung

The table, which shows the equation between *skar rtsis* and *nag rtsis* in terms of month reckoning, looks not to evince any conflicting issues with the above Ishihama and Yumiko's table. However, things may be more complex. Firstly, let me introduce Yum pa's excellent research into the month-reckoning system: 1) The Sde srid's *Vaiḍūrya dkar po* / Dharmaśrī's *Zla ba'i 'od zer* present the following table.

seasons (T. *dus bzhi*)	three spring months (T. *dpyid zla gsum*)			three summer months (T. *dbyar zla gsum*)			three fall months (T. *ston zla gsum*)			three winter months (T. *dgun zla gsum*)		
month count (T. *zla grangs*)	11	12	1	2	3	4	5	6	7	8	9	10
month name (T. *zla ba'i ming*)	*stag*	*yos*	*'brug*	*sbrul*	*rta*	*lug*	*sprel*	*bya*	*khyi*	*phag*	*byi*	*glang*
(T. *nya skar*)*	*mgo*	*rgyal*	*mchu*	*dbo*	*nag pa*	*sa ga*	*snron*	*chu stod*	*gro bzhin*	*khrums stod*	*dbyu gu*	*smin drug*

* *nya skar*: the position of *skar ma* at the time of full moon day (the 15th day). See Bsam 'grub rgya mtsho (2011: 153).

Klong rdol bla ma (1985: 50-1) shows this equation. For example, *dgun zla 'bring po* is equated with *dbyu gu zla ba* (9th month).

2) *Nag rtsis utpala sngon po'i do shal lugs kyi zla ba bcu gnyis* are as follows:

seasons (T. *dus bzhi*)	three spring months (T. *dpyid zla gsum*)	three sumer months (T. *dbyar zla gsum*)	three fall months (T. *ston zla gsum*)	three winter months (T. *dgun zla gsum*)

pa 'byung dus yod de / dgun stod dang / dgun smad dang / dpyid stod smad dang / dbyar stod dbyar smad drug la zla ba gnyis gnyis yod pas zla ba phyed gnyis 'das / phyed lus pa'i mar ngo drug la bcu bzhi pa re re ste drug dang lhag ma bco brgyad bco lnga pa yin pa'i phyir te / mdzod 'grel las / dgun dang dpyid dang dbyar rnams kyi / zla ba phyed dang gnyis 'das shing / zla ba phyed ni lus

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month count (T. *zla grangs*)	12	1	2	3	4	5	6	7	8	9	10	11
month name (T. *zla ba'i ming*)	*stag*	*yos*	*'brug*	*sbrul*	*rta*	*lug*	*sprel*	*bya*	*khyi*	*phag*	*byi*	*glang*
(T. *nya skar*)	*rgyal*	*mchu*	*dbo*	*nag pa*	*sa ga*	*snron*	*chu stod*	*gro bzhin*	*khrums stod*	*dbyu gu*	*smin drug*	*mgo*

Some Tibetan scholars such as 'Bri gung Chos kyi grags pa (1595-1659), Mkhas mchog Karma Chags med (1613-1678), Dge rtse 'Gyur med bstan pa rgya mtsho (this one is 'Gyur med bstan pa rnam rgyal (1886-1952) who is the author of *'Byung rtsis dpyad don rmad byung utpal sngon po'i do shal* (TBRC accession number W25167)) are mentioned as those who followed the above method.

3) *Nag rtsis nyer mkho bum bzang lugs kyi zla ba bcu gnyis* are as follows:

seasons (T. *dus bzhi*)	three spring months (T. *dpyid zla gsum*)			three sumer months (T. *dbyar zla gsum*)			three fall months (T. *ston zla gsum*)			three winter months (T. *dgun zla gsum*)		
month count (T. *zla grangs*)	1	2	3	4	5	6	7	8	9	10	11	12
month name (T. *zla ba'i ming*)	*stag*	*yos*	*'brug*	*sbrul*	*rta*	*lug*	*sprel*	*bya*	*khyi*	*phag*	*byi*	*glang*
(T. *nya skar*)	*mchu*	*dbo*	*nag pa*	*sa ga*	*snron*	*chu stod*	*gro bzhin*	*khrums stod*	*dbyu gu*	*smin drug*	*mgo*	*rgyal*

This is Karma Nges legs bstan 'dzin's (1700- ?) system. — For him, see Sobisch (2002: 274). The *nyer mkho bum bzang* was written in 1732. See also Schuh (1973: 292). — If we look at the above tables given by Yum pa, we can easily recognize that first (T. *ra ba*), middle (T. *'bring*), and last (T. *tha chung*) in each season are differently equated with *nag rtsis* and *skar rtsis*. For example, there are three possibilities for the *dgun zla 'bring po* (fixed as *byi ba'i zla ba*) in the case of *skar rtsis*: *dbyu gu zla ba* (9th month), *smin drug zla ba* (10th month), and *mgo zla ba* (11th month). Now, it is clear that the above Ishihama and Fukuda (1989), in which *dgun zla 'bring po* is equated with *rgyal* (12th month), causes a problem: which system are the Mongolian *Mahāvyutpatti*s based upon in terms of season? Are they Mongolian variations which accommodate Mongolian seasons? Or, are they based upon different manuscripts or traditions from the three raised by Yum pa? More research is needed. My point is that more broadly, in case that *gso sbyong* is reckoned just by season, we should be cautious. In that case, we should first investigate which system the author uses. Of course, if is reckoned according to / together with *nya skar*, the problem would not occur.

pa na / mkhas pas zhag mi thub pa dor / zhes dang /[186] *shā tam las / de la gso sbyong bcu bzhi dang bco lnga pa ni / dus tshigs drug po dag gi / zla ba bcu gnyis la gso sbyong nyi shu rtsa bzhi yod pas drug ni gso sbyong bcu bzhi pa yin la bco brgyad ni gso sbyong bco lnga pa yin te / zhes gsungs pa'i phyir /*[187]*gso sbyong bcu bzhi pa zla ba gang la byed pa yod de / rgyal / dbo / sa ga / chu stod / khrums / smin drug rnams kyi mar ngo la bcu bzhi pa 'byung ste / lo dri bar / rgyal dang dbo dang sa ga dang / chu stod khrums smad smin drug bcas / 'di rnams kyi ni nag po'i phyogs / zla phyed gso sbyong bcu bzhi pa / zhes gsungs pa'i phyir*[188] */ … .*[189]

Here, there are 24 *gso sbyongs* at a fixed time (*dus 'brel kyi gso sbyong*). It is because, in this case, there is no leap month during a year, there are 12 months, and there is *gso sbyong* each in waxing (S. *śuklapakṣa*) and waning moon phases (S. *kṛṣṇapakṣa*) of each month. Because it is stated in the root text, "on the 15th day of half month each" and in the *Dge slong gi lo dri ba*, "how many *gso sbyong*?" "twenty-four: *gso sbyong*s in the waning phases of the middle month of winter (*dgun zla 'bring po*), the first and third months of spring (*dpyid zla ra ba / tha chung*), the middle month of summer (*dbyar zla 'bring po*), the first and third month of autumn (*ston zla ra ba / tha chung*) are *gso sbyong* on the 14th day. The others are the *gso sbyong* on the 15th day." Because it is stated as such, there are times of *gso sbyong* on the 14th day and *gso sbyong* on the 15th day. Because there are two months each in the six seasons, i.e., early winter (*dgun stod*), later winter (*dgun smad*), early and late spring (*dpyid stod / dpyid smad*), early and late summer (*dbyar stod / dbyar smad*), [*gso sbyong* falls on], the 14th each in the six waning moon phases in which one and half months passed and the half remains, and the remainder 18 cases are the 15th. Because the *Abhidharmakośabhāṣya* states that if one and half months of winter, spring, and summer passed and half month remains, scholars omit the *zhag mi thub* (S. *ūnarātra / ūnarātri*)[190] and the *Shā tam* (= Guṇaprabha's

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[186] Vasubandhu (Dbyig gnyen), *Chos mngon pa'i mdzod kyi bshad pa* (S. *Abhidharmakośabhāṣya*), *Bstan 'gyur dpe bsdur ma*, vol. 79: 383.

[187] Guṇaprabha (2009: 294).

[188] Kha che Mkhan po Na ra sa de ba (S. Narasadeva), *Dge tshul gyi dang po'i lo* (S. *Śrāmaṇeravarṣāgrapṛcchā*), *Bstan 'gyur dpe bsdur ma*, vol. 93: 908.

[189] 'Jam dbyangs bzhad pa I (2011: 67-8).

[190] Vogel (1997: 679) renders it as "a night less," or "having a night less" with a good explanation of it: "as the lunar month has roughly $29\frac{1}{2}$ civil days and the civil day is taken in India to run from sunrise to sunrise, *ūnarātri* could originally have been either the night wanting from the last day of the month or the last day of the month lacking a night." However, his following indication is incorrect: "it [= *Mūlasarvāstivāda Vinayavastu*] offers the only instance found in Buddhist literature as yet of the term *ūnarātri* serving to designate the missing 15th day." It also appears when Vasubandhu explains about the synodic month in the *Abhidharma* texts. See de la Vallée Poussin (1869-1938) (1926: trosième chapitre, 180) [= English translation, Pruden (1988-1990: Vol. 2, 475, 541)]. The Chinese original text that de la Vallée Poussin used is as follows: *Apidamo jushelun bensong* (阿毘達磨俱舍論本頌 (CBETA, T29, no. 1560) translated by Xuanzang (玄奘 (602 ~ 664)). S. *Abhidharmakośakārikā*. / T. *Chos mngon pa'i mdzod kyi tshig le'ur byas pa*). The term appears in the

(Yon tan 'od) *'Dul ba'i las brgya rtsa gcig gsal bar ston pa karma sha tam* / S. *Karmaśataka*) states that as for *gso sbyong* on the 14th and the 15th day because there are 24 *gso sbyong*s in the 12 months of the six seasons, the six cases are *gso sbyong* on the 14th day, and the 18 cases are *gso sbyong* on the 15th day, *gso sbyong* on the 14th day exists in which month: *gso sbyong* on the 14th occurs in the waning phases of *rgyal*, *dbo*, *sa ga*, *chu stod*, *khrums*, and *smin drug*, and because *Dge slong gi lo dri ba* states [in] the half month, the black part (S. *kṛṣṇapakṣa*) of

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following way:
T29n1560_p0315c10(00) ║ 此三十晝夜 三十晝夜月
T29n1560_p0315c11(00) ║ 十二月為年 於中半**減夜**
Pruden's translation of the second line (1988–1990: vol. 2, 475) is: "is of twelve months by adding the *ūnarātra.*"
T29n1560_p0315c12(00) ║ 寒熱雨際中 一月半已度
T29n1560_p0315c13(00) ║ 於所餘半月 智者知**夜減**
Further, the same phrase appears in the same author's auto-commentary to *Apidamo jushelun bensong*, *Apidamo jushelun* (阿毘達磨俱舍論) (CBETA, T.29, no. 1558) T29n1558_p0062b24(00) ~ T29n1558_p0062b25(00) translated by Xuanzang into Chinese (S. *Abhidharmakośabhāṣya* / T. *Chos mngon pa'i mdzod kyi bshad pa*). It is the phrase 'Jam dbyangs bzhad pa I meant in the above passage. Of course, he meant the Tibetan *Chos mngon pa'i mdzod kyi bshad pa*. Pruden's (1988–1990: vol. 2, 475) translation of the above phrase: "When one month and a half of the cold, hot, rainy season has elapsed, the learned omit one *ūnarātra* in the half-month that remains." In it, it is verified that *zhag mi thub* is a rendering of *ūnarātra*. "*ūna*" means "short of the right quantity, fewer." Its Tibetan rendering *mi thub* is faithful to the sanskrit word. "*rātra*" means "night." Xuanzang's rendering *ye* (夜) is faithful to the sanskrit word but may not be to Tibetan: "*zhag*" is "day," not "night." The second meaning given by Vogel "the last day of the month lacking a night" may work better for the Tibetan rendering, *zhag mi thub*. Regarding the etymology of this term, read also Vogel (1997: 679). The term may be literally rendered as "a night that is short of the right quantity." The above phrase is related to the practice of *poṣadha* / *gso sbyong* inextricably tied to the motion of the moon, as de la Vallée Poussin (1926: trosième chapitre, 180) [= Pruden (1988-1990: vol. 2, 541, no. 490)] points out. Let me add two things to reinforce his explanation in Tibetan context: first, the seasonal difference of the practice of *gso sbyong*. The length of the synodic month is around 29.53059 days (*nyin zhag*) in the case of *Phug pa grub rtsis*. On average, during winter season, there are more months with 30 days than those with 29 days; meanwhile, during summer season, there are more months with 29 days than those with 30 days. In other words, according to the synodic month, winter season is longer; summer season is shorter. The reason is because in the winter season in which the Earth is near perihelion (the nearest point (apside)), it revolves faster around the Sun. As a result, the length of the synodic month becomes longer. Meanwhile, in the summer season, in which the Earth is near aphelion (the farthest point), it revolves slower. As a result, the length of the synodic month becomes shorter. Thereby, *ūnarātra* (*zhag mi thub*) occurs more in the summer season than in the winter season. This may lead to the seasonal frequency of the *gso sbyong* practice. Second, the close link between the *gso sbyong* interval and intercalation. The duration of the *poṣadha* makes 354 days in total because there are six *cātuddasī*s ($6 \times 14 = 84$ days (T. *nyin zhag*) and 18 *paṇṇarasī*s ($18 \times 15 = 270$ days). As there are approximately 365.27065 days (*nyin zhag*) during a year in the case of *Phug pa grub rtsis*, there is around 11.27065 day difference ($= 365.27065 - 354$) every year. Every three years, the difference becomes around 33.81195 days and make two *paṇṇarasī*s, with 3. 81195 days still remaining. The remainder is also accumulated and becomes another intercalary month. The quantity 354 means the approximate length of the lunar year, i.e., 354 ~ 355 days, 383 ~ 385 days in case that there is an intercalary month (S. *adhikamāsa/ adhimāsa*).

> these *rgyal*, *dbo*, *sa ga*, *chu stod*, *khrums smad*, and *smin drug*[191] [exists] the *gso sbyong* on the 14th day ... .

Being based upon the Indic *Mūlasarvāstivāda* texts, *gso sbyong* is performed on the 14th day (six times) and on the 15th day (18 times) a year in Tibet. There are 24 times a year in total. As seen above, a rationale Tibetan scholars use for the difference between 14th day and the 15th day for *gso sbyong* is *ūnarātra* (*zhag mi thub*), which appears in the *Abhidharma* texts. Using the concept to explain the dates of *gso sbyong* looks unprecedented in India, albeit it is a relevant concept to *gso sbyong* in terms of day-reckoning in Indian lunar calendrical system.[192]

Next, how the concept was used in relation to *gso sbyong* in Tibetan context is as follows. In Tibet, *zhag mi thub*[193] has been understood to be related to the difference

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[191] For this information, see *Bod rgya tshig mdzod chen mo* (2000: 3029). For the ordinal numbers of the above six months in the Tibetan *skar rtsis* system which fixes the third month as *nag zla*, see Lcang skya III et al. (1982: 51-2), Lcang skya III et al. (2002: 1174-8): *zla ba gnyis pa* (*qoyaduɣar sar-a*): *dbo zla* (*udarabalguni sar-a* < S. *uttaraphālgunī / phālguna*), *zla ba bzhi pa* (*dütüger sar-a*): *sa ga zla ba* (*sege / saga sar-a* < S. *vaiśākha*), *zla ba drug pa* (*ǰirɣuduɣar sar-a*): *chu stod can* (*burwasad* < S. *pūrvāṣāḍhā / āṣāḍha*), *zla ba brgyad pa* (*naimaduɣar sar-a*): *khrums zla* [= *khrums smad*] (*burwabadrabad* < S. *bhādrapada*), *zla ba bcu ba* (*arbaduɣar sar-a*): *smin drug zla ba* (*kirdig sar-a* < S. *kārttika*). *zla ba bcu gnyis pa* (*arban qoyaduɣar sar-a*): *rgyal zla* (*bus / büs sar-a.* < S. *puṣya*). See also Schuh (2012: 1647-8).

[192] Vasubandhu's original meaning of *zhag mi thub* is related to the length of the synodic month and lack of day on a yearly/monthly basis. In Tibetan context, the logic has been applied to explaining the *gso sbyong*, which is practiced on a fortnightly basis. Especially, it has been used to provide a rationale for the *gso sbyong bcu bzhi pa* (*gso sbyong* on the 14th day). As Vogel (1997: 678) clearly mentions, "*poṣadha* always fell on full-moon or new-moon day," the accuracy of lunar calendar has been proved by the instances of the *gso sbyong bcu bzhi pa*. The clear-cut recognition of the difference between *tshes zhag* and *nyin zhag* in Tibet is also evidenced by them.

[193] This concept is based upon *zhag gsum rnam dbye* (the distinctions of three types of day) (see Bsam 'grub rgya mtsho [2011: 52-4]). For easy understanding, in the case of one day, *nyin zhag* is composed of 60 *chu tshod*, *tshes zhag* ranges from around 54 to around 64 *chu tshod*, and *khyim zhag* is around 1.015 *nyin zhag*. For more information, see below pp. 193-4 and note 508. The logic of *zhag mi thub* concerns the relative length of *tshes zhag* and *nyin zhag*: in case that *tshes zhag* is more than 60 *chu tshod* [= longer than *nyin zhag*], it is

between *tshes zhag* (S. *saura dina*) and *nyin zhag* (S. *sāvana dina*). For example, Dge 'dun grub (1391–1474) explains why the 14th day (*nyin zhag*) falls on the 15th day (*tshes zhag*) by citing Dharmamitra (early 9th c.).

> *tshes bco lnga zhes smos pas bcu bzhi pa yang bsdus te / ṭīkkar / 'di ltar tshes gcig nas bco lnga'i bar gyi nyi ma gang yang rung ba las nyi ma gcig chad pas spyir zhag bcu bzhi yod pa'i phyir / 'jig rten pa'i dbang du byas nas / bcom ldan 'das kyis kyang so so thar pa'i mdo las / gso sbyong bcu bzhi pa zhes gsungs par zad kyi / dngos su na zla ba'i ngo de'i tshes grangs gang la nyi ma gcig chad pa de nyid sa stong du dor bar zad kyi gso sbyong gi nyi ma 'di la nyi ma chad pa min pas gso sbyong bcu bzhi pa zhes bya ba'i nyi ma de nyid tshes bco lnga yin pa'i phyir ro zhes*[194] *dang / ... .* [195]

> By saying the 15th day, the 14th day is also subsumed: it is stated in the *Ṭīkā*, "because like this, [ ] lacks one day from being suitable whatever day from 1st to 15th [is concerned], generally 14 days exist. Because of that, from the perspective of lay people, Bhagavān also says *gso sbyong* on the 14th day in the *Pratimokṣa sūtra*, but actually, it is because lacking a day in whatever day of the phase of the moon is to leave it as empty space, but it does not lack in the day on the day of *gso sbyong*, the day called *gso sbyong* on the 14th day is the 15th day."

Although he relies on the Indic texts (Guṇaprabha's *'Dul ba'i mdo* / Dharmamitra's *'Dul ba'i mdo'i rgya cher 'grel pa*), it is not likely that Guṇaprabha and Dharmamitra explained the different dates and lack of day in relation to *gso sbyong*. His explanation for the difference

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called *zhag thub*; in the case that *tshes zhag* is less than 60 *chu tshod* [= shorter than *nyin zhag*], it is called *zhag mi thub*.

194 Dharmamitra (T. Chos kyi bshes gnyen), *'Dul ba'i mdo'i rgya cher 'grel pa*, *Bstan 'gyur dpe bsdur ma*, vol. 91: 267.

195 Dge 'dun grub (1999: 440).

between *nyin zhag* and *tshes zhag* as a ground for *zhag mi thub* is more concrete and definite in the following passage:[196]

> *nyin zhag las tshes zhag yud tsam phyed phyed kyis myur bar 'da' bas tshes zhag drug cu song ba na nyin zhag nga dgu yin pas zhag mi thub pa zhes bya'o / ṭīkkar / nyi ma gcig chad pa de nyid sa stong du dor bar zad ces pa dang*[197] */ nyi ma de nyid tshes bco lnga pa yin pa'i phyir ro / zhes dang*[198] */ ... .*[199]

> Because *tshes zhag* is a little faster than *nyin zhag* by half of half, 59 *nyin zhag* passed in case that 60 *tshes zhag* passed.[200] Therefore, it is called *zhag mi thub pa*. It is stated in the *Ṭīkā* that it is because lacking in a day is to leave as empty space and the very day is the 15th.[201]

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[196] Dge 'dun grub's above passage may be the earliest evidence that mentions *zhag mi thub* in terms of *gso sbyong*. The term *ūnarātra* (= *zhag mi thub*) in *Abhidharma* literature was commentated on by Tibetan commentators from early period. However, I think that we should check whether there exist pre-15th century examples that clarify the difference between *tshes zhag* and *nyin zhag* for the explanation of *gso sbyong*. I am skeptical that the Indic term *ūnarātra* had been used in relation to the practice of *poṣadha*. If my conjecture is justified, the logic of *zhag mi thub* applied to *gso sbyong* may be a good example by which the Tibetan interaction between astronomy and religion is read because the use of the concept may be related to the full-fledged development of the concept of day, *zhag gsum rnam dbye*. For the *zhag gsum rnam dbye* and its development in the 15th century, see above note 13.

[197] Dharmamitra, *'Dul ba'i mdo'i rgya cher 'grel pa*, *Bstan 'gyur dpe bsdur ma*, vol. 91: 267.

[198] Dharmamitra, *'Dul ba'i mdo'i rgya cher 'grel pa*, *Bstan 'gyur dpe bsdur ma*, vol. 91: 267.

[199] Dge 'dun grub (1999: 450).

[200] See above note 193.

[201] Dge 'dun grub (1999: 450).

In his exegesis, *gso sbyong* is basically *gso sbyong* on the 15th day (*tshes zhag*), and *gso sbyong* on the 14th day is actually *gso sbyong* on the 15th day because the 14th day (*nyin zhag*) is the 15th day (*tshes zhag*). Taking other examples using the same logic, Blo gros legs bzang (16th c.), who was the 9th *khri rabs* at the monastery of Bkra shis lhun po and was Legs pa don grub's (1479-1555) student, writes,

> *de bcu bzhi pa rnams de bco lnga pa snga ma 'das pa nas tshes zhag bco lnga lon kyang / nyin zhag bcu bzhi las ma lon pa'i gso sbyong yin pas na de bcu bzhi pa dang / gso sbyong snga ma 'das nas nyin zhag bco lnga lon pa'i dus kyi gso sbyong gcig la de bco lnga pa zhes brjod pa yin pa'i phyir / ... / tshes zhag gis nyin zhag gi dod mi thub pa la brten pa'i gso sbyong yin pa'i rgyu mtshan gyis mi thub pa'i gso sbyong zhes brjod pa yin pa'i phyir te / ... 'on kyang gso sbyong bcu bzhi pa rnams tshes zhag gi dbang du byas pa'i gso sbyong bco lnga pa yin te / ... bam po lnga bcu pa las / tshes grangs kyi yang dag pa la ltos nas ni thams cad bco lnga pa yin no / zhes gsungs pa'i phyir*[202] */ des na gso sbyong bco lnga pa yin na / nyin zhag gi dbang du byas pa'i de bco lnga pa yin pas khyab ste / gso sbyong de gnyis kyi khyad par nyin zhag la ltos nas bzhag pa yin pa'i phyir te / ... .*[203]

> The 14th *gso sbyong*s are the 14th *gso sbyongs* because they reached the 15th *tshes zhag* from the previous 15th day passed, but it did not get out of the 14th *nyin zhag* (= still the 14th *nyin zhag*), and it is because a *gso sbyong* at the time when it reached the 15th *nyin zhag* from the previous *gso sbyong* passed is said to be *gso sbyong* on the 15th day. ... It is because it is said to be *gso sbyong* of *mi thub pa* by the reason that it is *gso sbyong* relying upon not being able to substitute for *nyin zhag* by *tshes zhag*. ... However, *gso sbyong* on the 14th days are *gso sbyong* on the 15th day in terms of *tshes zhag*, ... Because Vimalamitra's *So sor thar pa'i rgya cher 'grel pa bam po lnga bcu pa* states that all are the 15th day with respect to the accuracy of date, therefore, in the case of *gso sbyong* on the 15th day, it is necessarily *gso sbyong* on the 15th day in terms of *nyin zhag*. The peculiarity of the two *gso sbyong*s is due to arranging them with respect to *nyin zhag*.

It is verified again that there are two occasions: *gso sbyong* on the 14th day (*nyin zhag*) and *gso sbyong* on the 15th day (*nyin zhag*). The day reckoning for the nomenclature of *gso*

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202 Vimalamitra, *So sor thar pa'i mdo rgya cher 'grel pa 'dul ba kun las btus pa. Bstan 'gyur dpe bsdur ma*, vol. 85: 74. For Vimalamitra, see Germano (2002).

203 Blo gros legs bzang (2005: 348-9).

sbyong is according to *nyin zhag*. If the difference between *tshes zhag* and *nyin zhag* is taken into account, all the *gso sbyong*-s fall on the 15th day (*tshes zhag*). To take another example, Paṇ chen Bde legs nyi ma (16th c.) explains it in the same manner with Legs pa don grub.

> *'o na gso sbyong thams cad bco lnga pa ma yin nam / bcu bzhi pa 'byung ba'i rgyu mtshan ci yin zhe na / yod de / tshes zhag gis nyin zhag gi dod ma thub pa'i dbang gis bcu bzhi pa 'byung ba'i phyir te / gso sbyong bcu bzhi pa 'byung ba'i dus de tshes zhag bco lnga pa yin kyang nyin zhag bcu bzhi pa yin pa'i phyir / … .* [204]

> Well, then, if you ask what is the reason why all *gso sbyong*s are not 15th or the 14th (also) occurs, there is: it is because *gso sbyong* on the 14th day occurs because *nyin zhag* cannot be substituted by *tshes zhag*, and because the time when *gso sbyong* on the 14th day occurs is the 15th *tshes zhag* but is the 14th *nyin zhag*, … .

Again, there are two possibilities for *gso sbyong*: 1) *gso sbyong bcu bzhi pa*: 14th *nyin zhag*, but 15th *tshes zhag*, 2) *gso sbyong bco lnga pa*: 15th *nyin zhag* and 15th *tshes zhag*. In both cases, *gso sbyong* is held on the 15th *tshes zhag*. In the first case, *nyin zhag* is longer than *tshes zhag*.

There are two issues to think about regarding *gso sbyong* practice in Tibet: First, applying the difference between *nyin zhag* and *tshes zhag* to explain the *gso sbyong* on the 14th day (*nyin zhag*) apprears to be a Tibetan indigenous interpretation even if Tibetan scholars cited Indic texts. In fact, I have not found the instance in Indic texts directly relating *ūnarātra* to *poṣadha*. The issue is open to Indologists. Second, in conjunction with the first issue, in the Tibetan interpretation of *zhag mi thub*, the length of the lunar month according to the planetary movement, which was meant originally in the Indic texts, may

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204 Paṇ chen Bde legs nyi ma (2011: 141).

not be the concern for the observance of *gso sbyong* in Tibet. Rather, a focus may have been given to the accuracy of *tshes zhag*: the claim that all the *gso sbyong* dates fall on the 15th when being counted by *tshes zhag* is possibly the expression of the confidence in the *skar rtsis* system. Tibetan scholars have paid attention to the logic of *zhag mi thub* in order to justify the accuracy of *tshes zhag* buttressed by the accurate *skar rtsis* system. Then, why the accuracy of *tshes zhag* matter? It may be related to the fact that the accurate *tshes zhag* is a minimum requirement for *skar rtsis* to be accurate. Also, in the Tibetan relgious calendar, the *tshes zhag* reckoning has religious implication. For example, calculating correct full-moon days according to *tshes zhag* is crucial for religious life in Tibet.

2. A SURVEY OF LATER PERIOD PRACTICE OF *GSO SBYONG* WITH RESPECT TO AN ECLIPSE: *YUL BSTUN GSO SBYONG* (*GSO SBYONG* IN CONFORMITY WITH REGION)

RGYA RTSIS DATE AND *YUL BSTUN GSO SBYONG*

Sum pa Mkhan po (1979c) includes letter exchanges three times with an astronomer named Ngag dbang nyi ma.[205] In the letters, local unfolding of vinaya with respect to eclipse in 18th century Amdo is understood. It is also understood that, with the emergence of the Chinese calendar, the pratice of *gso sbyong* took a new turn. The second

[205] In the third letter to Ngag dbang nyi ma in Sum pa Mkhan po (1979c: 95b), Ngag dbang nyi ma is identified as "*sku 'bum pa rab 'byams sde snod 'dzin pa*" ("universally learned holder of the *tripiṭaka* at Sku 'bum").

exchange of letters in 1785/1786 shows Ngag dbang nyi ma's questions on *gso sbyong* date in relation to the Chinese date.

> *yang hor zla bdun pa'i rgya rtsis kyi tshes gcig lta bu la nyi 'dzin byung / de nas chos* (*sic.* seems to be *tshes*) *chad* (*sic.* read *'chad*) *pa'i dbang gis rgya rtsis kyi de'i bco lnga la zla 'dzin byung pa e srid / srid na de'i tshe gso sbyong bco lnga pa de ltar byed / de bzhin du hor zla bdun pa'i stong lta bur nyi 'dzin byung na nyin de 'dul lugs kyi stong yin nam min / yin na rang re'i gzhi gsum cho gar stong la zhag mi thub kyi* (*sic.* read *kyis*) *gso sbyong mi bya bar gsungs pa ji ltar lags / min na nyer dgu las 'os med pas 'dul lugs la nyer dgu la gza' 'dzin byung ba zhig srid par e 'gyur lags /*[206]

> Also, is it possible that the solar eclipse occurs on such a day as the first *rgya rtsis* day of the seventh *hor zla* and thereafter, the lunar eclipse occurs on the fifteenth *rgya rtsis* day due to the absence of the lunar day? If possible, *gso sbyong* on the fifteenth day is performed at that time? In the same way, if the solar eclipse occurs on the new moon day of the seventh *hor zla*, is the date new moon day of Vinaya tradition or not? If it is, how to deal with the statement that *gso sbyong* should not be performed because of *zhag mi thub* on the thirtieth day in the three basic monastic *rites* (T. *gzhi gsum cho ga*)? If not, because nothing is appropriate other than the twenty-ninth, will it be the case that the occurrence of the eclipse on the twenty-ninth becomes possible in Vinaya tradition?

His letter reflects the situation that the different date between *skar rtsis* and the Chinese calendar causes confusion in the Indian vinaya practice in monasteries in Amdo. The recognition must have derived from the observation that solar eclipses occasionally occurred according to Chinese date, not according to *skar rtsis* one.[207] Sum pa Mkhan po's answer is as follows[208]:

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[206] Sum pa Mkhan po (1979c: 90b).

[207] Chinese lunar calendar is focused on calculating the new moon day (*shuo* 朔) (the Sun, Moon, and the Earth are aligned) which falls on the 1st lunar day. A solar eclipse occurs only on that day. The full moon day (*wang* 望) (the Sun, the Earth, and the Moon are aligned) is not always 15th lunar day, and it may be the 16th or 17th. A lunar eclipse occurs on the full-moon day. Meanwhile, Tibetan lunar calendar is focused on calculating the full moon day which falls on the 15th *tshes zhag*. Thereby, a lunar eclipse always occurs on the 15th *tshes zhag*, but a solar eclipse may not always occur on the 30th (*tshes zhag*). — Of course, timing corrections have been made for eclipse calculations possibly on the basis of empirical data. — For example, a solar eclipse occurred in some areas of East Asia on 1786/1/1 (according to the Qing Chinese lunar

... skar rtsis nyin zhag ltar dang rgya rtsis ltar ni rags la / tshes zhag ltar ni zhib pa dris lan snga mar dang 'og tu'ang smos ltar dang / khyad par du 'dul lugs la'ang rags zhib gnyis mod de / bcom ldan 'das rgya gar du zhal dngos thun mong ngor bzhugs dus su / dge slong rnams kyis thog mar zla re'i yar ngo mar ngo'i nyi shu (sic. maybe *nyi shu rtsa bzhi) dang zhag mi thub zla bshol ji bzhin brtsi pas gzhan kyis 'phyas pa na lo rer rang sangs rgyas kyi bkas lo drug rer zla bshol bton pa ni rags rtsis yin kyang / de dus su dus 'brel gyi gso sbyong dbyar khas len dgag dbye yang yang mdzad pa dang / phyis su de dag yul spyi'i zhag zla brtsi tshul dang ma mthun pas kun gyis 'phya pa na / bcom ldan 'das kyis khyim bdag bram ze 'phya ba ni gus te / rgyal po'i gzhung dang skar rtsis ba'i rjes su 'brang bar bya'o / zhes gzhung dam pa bam po sum bcu pa sogs las gsungs pa ni*[209] *skar rtsis lta bu zhib rtsis ltar yang rung bar gsung la / de ltar na yul gang du'ang zla zhag brtsi tshul dang 'dul ba'i lag len ni ji ltar grags pa de ltar bya rung ngam snyam / des na ...*[210] *dang mdo khams kyi yul 'dir yang 'dul ba yul dus dang bstun dgos zhes pa ltar bod kyi skar rtsis la chad lhag ji bzhin bton pa zhib pa ltar deng sang dbus gtsang du de ltar byas pa zhag* (sublinear note : *04 ?*) *la nor* (sublinear note : *15*) *'khrul med pas lags la / yang rgya nag dang 'dab 'brel bar nye bas rgya'i rgyal po'i lugs dang 'byung rtsis ni skar rtsis las cung zad rags kyang de dang mthun dgos pa'i a mdo'i yul 'di lta bur de dang bstun nas dus 'brel gso sbyong bya rung bar khums /*[211]

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calendar). — For the occurrence, see below note 527. — The date also falls on 1786/1/1 according to *Phug pa grub rtsis* calendar. Because the solar eclipse occurred after *nam langs* (according to Tibetan time), it was certainly 1/1. — The solar eclipse was calculated by A kya; see Chapter 4. For the religious issues of the solar eclipse on 1786/1/1 pertaining to *gso sbyong*, see below note 248. — The disagreement between lunar date and an eclipse is related to the fact that the synodic month is around 29.5 days, not 30 days (civil day).

[208] Sum pa Mkhan po's answer is wide off the mark in this letter: he does not specify which *skar rtsis* (or *rgya rtsis*) date is appropriate or inappropriate for *gso sbyong*. It seems that he just has overall sense of the practice of *gso sbyong*, which accommodates both Indic *skar rtsis* and Chinese *rgya rtsis* with a great focus on the former. Of course, we can understand from his answer that he also admits *gso sbyong* cannot be followed strictly according to *skar rtsis*, as frequently evidenced by the occurrence of eclipse. As for the answers for the Ngag dbang nyi ma's questions, we may be able to Sum pa Mkhan po (1979c: 79a-79b) in the first correspondence and Gser tog (1982: 234): they are based upon the same idea, which may mean that their ideas and approaches were widespread at that time. In conjunction with this, it should be stressed that the problems raised by Ngag dbang nyi ma may be also common religious issues at that time in Amdo. We may be able to see more evidence through textual study.

[209] The story is seen in the *'Dul ba Gzhung dam pa*, *Bka' 'gyur Dpe bsdur ma*, vol. 13: 165-70.

[210] illegible.

[211] Sum pa Mkhan po (1979c: 93b-94a).

> … That which [day reckoning] is rough according to *nyin zhag* of *skar rtsis* and *rgya rtsis* and [day reckoning] is accurate according to *tshes zhag* is as said in the previous reply and (will be said) below, and especially also in Vinaya tradition, there are two, rough and subtle, but the statements in the *Gzhung dam pa* (S. *Uttaragrantha*) section 30 (*bam po sum bcu pa), etc.* that "when Bhagavān stayed in India in person among ordinary people, monks firstly calculated 20 (maybe 24?) waxing/waning phases of each month, *zhag mi thub*, leap month as they are and then were blamed by others, placing the leap month every six year annually by Pratyekabuddha's words is the rough calculation (*rags rtsis*), but he performed *gso sbyong* at a fixed time, accepted summer retreat, performed *dgag dbye* at that time, and when [he] was blamed later by all because those did not accord with the way of calculation of day and month of the region, Bhagavān accommodated the blame by the householders and Brahman, and spoke that *Rgyal po'i gzhung* (?) and *skar rtsis* should be followed" is spoken appropriately also according to accurate calculation (*zhib rtsis*) such as *skar rtsis*, etc., and if it is the case, I think that it would be appropriate that, in whatever place, reckoning of month, date, and practice of Vinaya should be made according to those known. Then, I think that in … and in Mdo khams here also, as is said that [the practice of Vinaya] needs to tally with regional time (*yul dus*), it is good because the practice made nowadays in Dbus gtsang according to the fine one, which is that *lhag chad* is placed according to Tibetan (*bod*) *skar rtsis*, is unmistaken in reckoning days and also, although Chinese Emperor's tradition and *'byung rtsis* are a little more rough than *skar rtsis*, it is suitable to perform *gso sbyong* at a fixed time by tallying with them in Amdo, etc., where [ ] need to tally with them due to the proximity to China.

Different dates between *skar rtsis* and the Chinese calendar and the relevant problems in the performance of *gso sbyong* caused by them are clearly depicted in the above letter. In response to Ngag dbang nyi ma's questions on the timing of *gso sbyong* caused by the Chinese calendar, which was being used in Amdo,[212] Sum pa Mkhan po provides a solution based upon the Indian Buddhist Vinaya text *Uttaragrantha*: with it, he justifies his suggestion of *yul bstun gso sbyong* (*gso byong* in conformity with region). It should be also noted that, even if he argues for the idea of *yul bstun gso sbyong*, he does not argue that

[212] Another evidence that the Qing Chinese day-reckoning system different from that of Tibetan calendar was being used in determining the date of *gso sbyong* in the 18th century Amdo is seen in the biography of Thu'u bkwan III. Thu'u bkwan III's activity in Dgon Gsar thar pa gling in Amdo one time at the age of 47 (1783 C.E.) conveys the following information. Gung thang Bstan pa'i sgron me (1992: 383): "… [For] eighteen *gso sbyong* on the 15th days and six *gso sbyong* on the 14th days during a year, the unmistaken and unbroken counting method of the number of *nyin zhag* after tallying with *rgyas rtsis* of the regional tradition (T. *yul lugs*) is needed and … . " (*lo gcig la dus 'brel gyi gso sbyong bco lnga ba bco brgyad dang bcu bzhi ba drug rnams yul lugs kyi rgya rtsis dang bstun nas nyin zhag gi grangs rtsi tshul ma nor zhing ma chad pa dgos pa dang /… .*).

skar rtsis is problematic. Rather, he holds that *skar rtsis* is more accurate than Chinese calendar in terms of day reckoning in Dbus gtsang, and the fact that *skar rtsis* does not accurately reflect date in Amdo is due to regional difference. Here again, it is verified that Tibetan astronomers find whatever possible rationale for conflcting and contesting sources in a way of being compatible with *skar rtsis* / the *Kālacakra*.

RELIGIOUS RITUAL AND LUNAR AND SOLAR ECLIPSES

Before tackling the relationship between *gso sbyong* and eclipse, let me tackle the religious meaning of eclipse with a focus on the 18th century context. Eclipse is a crucial part of religious practice in Tibet, and the observance of Buddhist ritual has been made according to an eclipse. It may be due to Tibetans' belief in the increase of merit in the case of religious practices performed during an eclipse.

The ideas are found in Tibetan texts including *rtsis*, *lo rgyus*, *rnam thar*, etc. As an example, Dalai lama V performed the following religious ritual upon the lunar eclipse in 1656: "On the 15th, there was an eclipse, and I intended to practise the violent rite of Mashi (Mashin) from the 11th by entering into a strict retreat and beginning to recite the *mantra* of Jamkar (T. 'Jam dbyangs dkar po)."[213] Another example: Gung thang Bstan pa'i

[213] Samten Karmay (2014: 364). About this ritual, see also Bstan 'dzin dpal 'byor (1987: 285) [= Bstan 'dzin dpal 'byor (1988: 238)].

sgron me records Thu'u bkwan III's performance of the *sādhana* at the age of 57 (water-female-ox year (*chu mo glang* 1793 C.E.)/7/15) at Mchod rten thang bkra shis dar rgyas gling (Ch. Tiantangsi 天堂寺) upon the occurrence of the lunar eclipse in the following way.

> *mtshan mo gza' 'dzin byung bar dmigs bsal gyi thugs dam mdzad rgyun par yang gza' 'dzin nam byung res (sic.* read *re) bzhin dmigs bsal gyi thugs dam la nan tan chen po mdzad pa zhig yod pa ni / rang byung rdo rje'i nang don las / srog rlung dkar dmar sbyor ba na / zla nyi 'dzin par snang ba dang / zhes pa ltar phyi nang gi rten 'brel mthun tshul dang / de'i dbang gis dge ba'i 'gyur khyad*[214] *'byung ba dus 'khor sogs bla med kyi rgyud sde du ma'i dgongs pa yin zhing / gsang ba spyi rgyud las kyang / nyi ma zla ba gzas zin dang / ya mtshan che ltas byung ba dang / cho 'phrul gyi ni zla ba la / bsgrims te dkyil 'khor bri bar bya / zhes shin tu 'phel che ba'i dus khyad par ba yin par gsungs so /...* [215]

> Upon the occurrence of the eclipse at night, although he constantly performed special *sādhana,* the existence of diligently performing special *sādhana* whenever each eclipse occurs is: as is stated by Rang byung rdo rje's inner meaning that if white and red life sustaining winds (T. *srog rlung*) are connected, the lunar and solar eclipses occur, [eclipse is] the way of agreeing with external and internal dependent origination and the appearance of the multiplication of virtue due to that, i.e., the intended meaning of many unsurpassable Tantra sections such as the *Kālacakra* and others, and as is also stated in *Gsang ba spyi rgyud* (**Sāmānyaguhyatantra*) that the sun and moon was held by Rāhu, the great wondrous sign occurred and [ ] should write *maṇḍala* with great concentration in the miraculous moon, Thu'u bkwan said that [the occurence of eclipse] is the extraordinary time of great progress.

Another example is seen in Phyag mdzod.[216] Also, Rdo ring pa Bstan 'dzin dpal 'byor (1760 ~ ?) dramatically shows the meaning and significance of an

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214 '*'gyur / bsgyur*' means 'times, multiple.' '*khyad*' means 'difference, uniqueness.' So, '*dge ba'i 'gyur khyad*' means 'the uniqueness of multiplication of virtue'. Simply, Tibetans believe that when one practices on the occasion of an eclipse, the virtue is multiplied.

215 See Gung thang Bstan pa'i sgron me (1992: 779).

216 Huang and Chen (1987: 37).

eclipse in Tibet on a religious and technical level. He calculated the values of the lunar eclipse in 1776.

> *zla ba bcu pa'i tshes bco lnga dpal lha'i ri rab kyi dus ston nub mo chu shel dbang por seng ge mo'i bu'i*[217] *gdong gis ril 'dzin gyi ri mo zhig 'char gyi 'dug stabs zla ba sgra gcan gyi sgo yig la gzugs 'gros dang / gsum bris / snyan ngag gi tshig rtsom sogs zab rgyas dang dod dang ldan par phyi nang gzhan gsum gyi sgo nas zla bar sgra gcan 'jug tshul dpal dus kyi 'khor lo'i rgyud gzhung gi dgongs pa dang mthun pa'i rgyas bshad dang bcas pa zhig lha ldan khyams ra gzhung sgo'i 'gag du sbyar bar 'dzin dus snga (sic.) dang / 'dzin cha che chung / phyogs cha sogs tshang ma ga (sic.* read *go) 'dzol med pa'i sgo yig nang ltar shin tu thigs pa byung song zhing / 'di skabs phur lcog sprul sku rin po che dang / nged rang gnyis kas rdo ring du lhan cig par ma ti mugs (sic.* read *lugs) kyi 'jam dbyangs dkar po'i bdag bskyed dang 'brel ba zla 'dzin byung mtshams nas ma grol bar ma sha'i sbyor ba la rten pa'i bzlas dmigs bskyangs par ... .*[218]

> Because the value of total eclipse by the head of Rāhu[219] to the moon arises in the feast *dpal lha'i ri rab kyi dus ston* (= a religious festival) at night on the 15th day of the 10th month, I drew the steps of the shapes (the picture of the moon and Rāhu ?) and the 3 (?) on the poster of the moon and Rāhu.[220] Upon my posting the poster with an extensive explanation regarding the way the moon was eaten by Rāhu which agrees with the intended meanings of the lustrous *Kālacakra* through the outer, inner, and other realms (*phyi nang gzhan gsum*) in a profound and vast way [by means of] such as poems of *snyan ngag*, etc, and vividly [by the picture] on a narrow point of the main gate of the yard of the Jo khang, Lhasa, everything such as earlier (?) timing of the occurrence of the eclipse, magnititude, size, direction, etc. occurred very accurately like the unmistaken poster, and in this occasion, Phur lcog sprul sku rin po che (Phur bu lcog 2 Blo bzang byams pa (1763–825)) and I, together in Rdo ring, [the tantric practice] related to the self generation of the physical form of white Mañjuśrī of *Ma ti* tradition/ method (tantric practice ?), in reciting

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[217] The *chu shel dbang po* refers to the moon. And *seng ge mo'i bu* (M. *ülügčin arslan-u kübegün*) refers to Rāhu. See Lcang skya III et al. (2002: 1195).

[218] Bstan 'dzin dpal 'byor (1987: 285) [= Bstan 'dzin dpal 'byor (1988: 238)]. For the Chinese translation, see Tang (1995: 127-8).

[219] *gdong 'dzin*.

[220] The sentence is not understandable in some respects. I have no idea what "*gsum*" here means. Something may be missing.

mantra, visualizing, and nurturing by relying upon the practice of pea from the beginning of the lunar eclipse before the termination of it, ...

The lunar eclipse (1776/10/15 = November 25, 1776) was successfully predicted, and the tantric practice was arranged. In the same manner with the case of Dalai Lama V, the mantra of white Mañjuśrī was recited and white Mañjuśrī was visualized. The description for a solar eclipse which he predicted to occur in 1776 reads as follows:

> *de rjes gnam stong la yang nyi 'dzin gyi ri mo zhig 'char gyi 'dug stabs / nyi mar sgra gcan mjug 'dzin yong tshul gyi sgo yig zhig bris par dge rgan 'gyur med rnam rgyal lags*[221] *nas / zla 'dzin gyi ri mo las nyi 'dzin 'di lta bus ma thigs tsam yong gi 'dug pas brtan po gyis zhes gsungs byung 'phral la blo the tshom du gyur kyang / ... .*[222]

> After that, because the value of solar eclipse appears also on the new moon day, upon my posting the poster which describes the occurrence by Rāhu's tail to the sun (*mjug 'dzin*), my teacher 'Gyur med rnam rgyal said, "do carefully because the value of solar eclipse is more inaccurate than that of lunar eclipse" I Immediately became doubtful.

As doubted by him, no eclipse occurred.[223] And then,

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221 His teacher 'Gyur med rnam rgyal is the teacher of *Lha rigs dga' ldan dbang phyug dpal 'ba*, the father of the present head of the monk at Smin grol gling, Rgya ri ba'i Zhabs drung Khri Rin po che. For the information, see Bstan 'dzin dpal 'byor (1987: 284) [= Bstan 'dzin dpal 'byor (1988: 237)].

222 Bstan 'dzin dpal 'byor (1987: 285-6) [= Bstan 'dzin dpal 'byor (1988: 238)]. For Chinese translation, Tang (1995: 128).

223 In fact, no solar eclipse happened in Tibet during the 10th, 11th, 12th months in the year of *me spre'u* (1776-1777). A solar eclipse occurred during that period, but not in Tibet. See http://eclipse.gsfc.nasa.gov/SEcat5/SE1701-1800.html: no. 08982: Jan 9, 1777: an annular solar eclipse occurred whose path crosses the North Atlantic Ocean. See http://eclipse.gsfc.nasa.gov/SEsearch/SEsearchmap.php?Ecl=17770109

de nyin tshang mas kha gnam rang la bltas nas bsdad song bar / nged rang nas kyang sgra gcan gyi nur ster lugs dang / shar nub ri bo'i mtho dma' / dbyar dgun gyi nyi ma dang sa khyad skor (sic. read *spor) thang brtsi (sic.* read *rtsis) lugs*[224] *sogs gang ci chug (sic. read 'chug) med zhib nan byas khul yin rung ri mor lag nor shor ba'am / yang na 'gro rnams dge la bskul ba'i kun slong rnam dag gis rtsis ma zin par pho gsar mkhas ngom gyi tshul du bkod gshis gzhan sems shes pa'i rnal 'byor pa rlung sems la rang dbang thob pa 'ga' zhig nas kho bo'i mkhas rloms kyi khengs pa 'joms par bya phyir nyi ma'i rang bzhin 'og rlung thur sel ser po dang / zla ba'i rang bzhin steng rlung srog 'dzin dkar po gnyis rtsa ā wa rdu ti'am dbu ma'i nang du kha sbyor bum pa can gyi tshul du bzungs bkyol (sic. read bkol) mdzad pa sogs ji ltar yin rung ... .*[225]

On that day, everyone opened mouth and looked over the sky. Although I pretended (humble way of saying) to calculate accurately without a mistake, (by using) the method of *nur ster* for Rāhu, east and west, height of mountain, the sun of summer and winter, territorial peculiarity, the tradition of *spor thang rtsis*, etc, whatever,[226] errors in the value occurred by hands, or because the young man (= I) wrote in the manner of boasting knowledge without calculating by pure motivation to exhort sentient beings to act virtuously, in order for some Yogis who know the mind of other people and attained mastery over *prāṇa*-mind to conquer my arrogance of bragging about knowledge, [they] hooked yellow downward-clearing wind (S. *apana vāyu* / T. *thur sel gyi rlung*), the nature of the sun, and white upward life sustaining wind (S. *prāṇa vāyu* / T. *srog dzin rlung*), the nature of the moon, together in the central channel (S. *avadhūti* / T. *rtsa dbu ma*) in the way of two vases being jointed together, etc. in whatever case.

The relationship between eclipse and religious practice within a broader frame is seen again. An eclipse has a close tie with tantric practice.

The religious aspect and concern on the occasion of an eclipse is also related to the practice of *gso sbyong*, which is one of the religious rituals in Tibet. Most of all, due to that, eclipse calculation and prediction were necessary for religious practice. Next, let me

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224 For *spor thang rtsis*, see Macdonald (1963: 74) introduces Thu'u bkwan III's opinion on *spor thang rtsis*; Geshe Lhundub Sopa (2009: 334): "Chinese divination translated into Tibetan during the Tang dynasty."

225 Bstan 'dzin dpal 'byor (1987: 285-7) [= Bstan 'dzin dpal 'byor (1988: 239-40)]. See also Tang (1995: 127-9).

226 The above considerations look common at that time. This will be also mentioned below in chapter 4. In essense, they are those that can be devised within the *Kālacakra* astronomy. When being juxtaposed with the *Mā yang rgya rtsis* (see chapter 4) which is based upon modern trigonometry, it is easily known that they cannot be fundemental solutions for the increase in the accuracy of solar eclipse calculations.

narrow down to *gso sbyong* with a focus on eclipse in the following section. I will illustrate the emergence of the Chinese calendar in Amdo and its influence on the traditional concept of *zhag mi thub*.

RELATIONSHIP BETWEEN *GSO SBYONG* AND SOLAR AND LUNAR ECLIPSES AND THE CHINESE DATE

In *skar rtsis*, the date of a lunar eclipse is fixed as the end of the 15th *tshes zhag* and that of solar eclipse is fixed as the end of 30th *tshes zhag*. Further, eclipses occur nearly on the same day with *gso sbyong*. Therefore, if an eclipse occurs on a different date, it may cause a problem with the integrity of the *skar rtsis* system and ultimately, a threat to the cooperative system between *Kālacakra* and *Vinaya* because *gso sbyong* is buttressed by *Kālacakra*-based calculational *skar rtsis* and the Buddhist texts of disciplines, and ritual practice according to Vinaya will not be performed properly in that case. The point will be mentioned in the following.

First, let me begin with the situation in which eclipse timing (*gza'* value) was not calculated accurately in Amdo in the 18th century by using Sum pa Mkhan po.

> *... zla gling ni mtshan mo zla 'dzin dus su lta byed dang / nyi gling ni nyin mo nyi ma 'dzin dus su lta byed yin pas / ... shing 'brug lo'i drug pa'i stong gi nyi 'dzin ... nyin de'i re (sic.) gza'i chu tshod ni tshes (15) bsres pas nyer gcig byung bas lho gling dbus mar 'dzin par shar ltar ro / 'on kyang*

nyi 'dzin nam (sic. read *gnam) stong la 'dzin dgos kyang ... gling 'dir tshes gcig gi snga gro (sic. read dro) mthong ba yod de ... .*[227]

... Because the moon (T. *zla gling*) is used in the observation in lunar eclipse at night and the sun (T. *nyi gling*) is used in the observation in solar eclipse during daytime,[228] ... the solar eclipse on the thirtieth day in the sixth month of wood-dragon year (1784 C.E.) ... the eclipse occurs in the center of the sourthern continent since twenty-one [*chu tshod*] occurred by adding fifteen to the *chu tshod* of the *res gza'*[229] of the day.[230] However, the solar eclipse should occur on the new moon day, ... but was seen in this continent in the morning of the first lunar day... .

To understand the above quotation, the following context should be understood: the lunar eclipse, which occurred on the 15th *tshes zhag*, was tallied with by adding 15 *chu tshod*, which derived possibly from empirical data, but, then again, the solar eclipse on the 30th day was not tallied with by using the same corrections as with the occasion of the lunar eclipse. The problem is not merely astronomical, it also causes a serious religious

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227 Sum pa Mkhan po (1979c: 81a).

228 My renderings for *nyi gling* and *zla gling* are tentative. They look to be special terms used in the *Dga' ldan rtsis gsar*. I did not find other reference except for these examples.

229 For the meaning of *res gza'*, see Henning (2007: 11).

230 This part is Sum pa Mkhan po's answer to Ngag dbang nyi ma's questions in the first correspondence. It is known from the questions and this answer that 15 *chu tshod*, the *gza'* value (*nur ster* value), has been added to the *gza' dag* calculated in 18th century Amdo in order to justify the *Kālacakra* world system. To briefly cite the relevant passages in the Ngag dbang nyi ma's questions in Sum pa Mkhan po (1979c: 80a): "... if 20 arises by adding fifteen to *tshes longs* (*tshes kyi longs spyod*) of this place, eclipse will be in the center of the southern continent, ... the practice of adding fifteen to *gza' dbyug* is just under the power of this continent." (*... grub sa 'di tshes longs la / tshes (15) byin pas mkha' mig (20) shar ba na lho gling dbus mar 'dzin par 'byung la / ... gza' dbyug la tshes (15) byin gyi cho ga byas pa'ang gling 'di kho na'i dbang du 'gyur ro /*). The *tshes longs* is *tshes kyi longs spyod* (daily motion). The *gza' dbyug* is the value of *dbyug gu* in the value of *gza'*. The *dbyug gu* (S. *ghaṭikā* (or *daṇḍa*)) is *chu tshod.*

problem. For example, the inaccuracy of weekday (*gza'*) value verified from eclipse phenomena creates confusion in deciding a day for *gso sbyong*.

Then, what would happen in case the Chinese calendar, not Tibetan calendar, showed the correspondence between the date and the occurrence of a solar eclipse? In the first exchange of letters, the Sku 'bum monk Ngag dbang nyi ma asked Sum pa Mkhan po twenty-seven questions on Buddhist texts and sciences (T. *rig gnas*).[231] The issues of the occurrence of eclipses and different dates according to different calendars with respect to the performance of *gso sbyong* are also included in them.

> *dri ba bcu gsum ni / ... bco lnga lta bur gso sbyong byed pa brjed nas bcu drug gi nyi ma ma shar gong du byas chog pa'i dmigs bsal gsungs pas / de'i tshe dus go ji ltar brjes lags / zhes pa 'di dogs gnas zhig yin pas lan ni / ... 'dul ba'i skabs 'dir gtso bor nyin zhag ltar byed la / ... / ... bcu drug gi skya rangs (sic. rengs) dang po ma shar yan bco lnga dang de shar tshun chad bcu drug du gtog (sic. gtogs) go / ...'dul gzhung du bco lnga la brjod sogs kyis de ma grub na bcu drug gi nyi ma ma shar gong du bya rung gsungs pa ni /... gal te phyi nyin rgya rtsis kyi gcig la nyi 'dzin byung na der gso sbyong bya dgos pa dmigs bsal dang ces pa'o / ... / nyi ma ma shar gong gi 'char kha'i dus de bco lnga'i mtshan mo'i cha la gtogs pas de'i gso sbyong la bco lnga'i zhes brjod na bde'am snyam / ...* [232]
>
> The 13th question: ... because a special case is stated that having forgotten performing *gso sbyong* on the 15th, it would be fine to perform [*gso sbyong*] before the 16th sun rises, how to change the date and time? Since there is a doubt as such, my answer is: ... The occasions of Vinaya here are mainly based according to *nyin zhag*, ... [The date] belongs to the 15th up until the first dawn of the 16th; belongs to the 16th after it rises.[233] ... As for the statement

[231] See Sum pa Mkhan po (1979c: 70b).

[232] Sum pa Mkhan po (1979c: 79a-79b).

[233] In the *skar rtsis*, one day (*nyin zhag*) is defined as follows: Bod ljongs gnam rig skar rtsis rig gzhung tshogs pa (1985: 88): "from a dawn when the lines of palm are visible to the next dawn when the lines of palm are visible." (*nam langs lag ris mthong ba nas / rjes ma'i lag ris mthong gi bar* /). Bsam 'grub rgya mtsho (2011: 53). In Chinese lunar calendar, midnight (Ch. *zizheng* 子正) is the beginning point of time measurement: One day is divided into 12 subsections of time called *shi'er shichen* (十二時辰) in which each subsection has two, *chu* (初) and *zheng* (正) and thereby makes 24 in total. For example, the time of mouse (*zi* 子) is divided into *zichu* (子初) and *zizheng* (子正). The following table is presented in the same manner.

in Vinaya that if by the explanation of the 15th, etc. it was not established, it would be fine to do [*gso sbyong*] before the sun of the 16th day rises: … if the solar eclipse occurs next day on the first day according to *rgya rtsis*, it is stated as a special case that *gso sbyong* should be done on that day. … I think that since the time immediately before [the sun's] rise belongs to the part of the night of the 15th day, it would be fine if [we] call the *gso sbyong* the *gso sbyong* on the 15th day… .

As seen above, Sum pa Mkhan po admits an exception that *gso sbyong* should be performed on the first day in case that a solar eclipse occurred according to the Chinese calendar. The suggestion is combined with the logic of *yul bstun gso sbyong*.[234]

dbus gtsang du skar rtsis ltar byas ba ni 'grig la / a mdo'i yul rgya rtsis dang bstun pa la mi 'grig pa mang du yod pa'i rgyu mtshan ni skar rstis kyi zla re'i chad lhag rang rang thad du bton pas lo re'i dus gzer bzhi dang zla re'i tshe brgyad nyer gsum la zla dkyil phyed pa dang bco lnga la nya gang sogs mig mthong dang ji bzhin 'grig cing / gling 'di'i nyi 'dzin yin na nyin zhag gi nam stong dang zla 'dzin rkyang ba yin na nyin zhag gi bco lngar 'ong bas khyab pa med kyang phal cher de dang der 'ong ba dang / tshes zhag ltar na yar ngo mar ngo'i mtshams su 'dzin sogs dus 'khor las gsungs pa dang yang 'grig sogs zhib la / … / khyad par du nyi 'dzin phal cher rgya nag gi rang lugs kyi zla phye'i tshes gcig dang zla 'dzin bcu drug la 'ong ba'ang mang ngo /[235]

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	zi (子)		*chou* (丑)		*yin* (寅)		*mao* (卯)		*chen* (辰)		*si* (巳)	
shier shichen 十二時辰	*zi chu* (子初)	*zi zheng* (子正)	*chou chu* (丑初)	*chou zheng* (丑正)	*yin chu* (寅初)	*yin zheng* (寅正)	*mao chu* (卯初)	*mao zheng* (卯正)	*chen chu* (辰初)	*chen zheng* (辰正)	*si chu* (巳初)	*si zheng* (巳正)
modern time	23~24	24~1	1~2	2~3	3~4	4~5	5~6	6~7	7~8	8~9	9~10	10~11

	wu (午)		*wei* (未)		*shen* (申)		*you* (酉)		*xu* (戌)		*hai* (亥)	
shier shichen	*wu chu* (午初)	*wu zheng* (午正)	*wei chu* (未初)	*wei zheng* (未正)	*shen chu* (申初)	*shen zheng* (申正)	*you chu* (酉初)	*you zheng* (酉正)	*xu chu* (戌初)	*xu zheng* (戌正)	*hai chu* (亥初)	*hai zheng* (亥正)
modern time	11~12	12~13	13~14	14~15	15~16	16~17	17~18	18~19	19~20	20~21	21~22	22~23

In *skar rtsis*, the hours from midnight to *nam langs* belong to the previous day; in the Chinese lunar calendar, they belong to the very day.

234 As a matter of fact, *yul bstun gso sbyong* is an exception of the principle of *zhag mi thub* in the practice of *gso sbyong*. Both of them are incompatible. For my explanation, see below pp. 108 ff and especially note 248.

235 Sum pa Mkhan po (1979c: 79b).

> It is appropriate if done according to *skar rtsis* in Dbus and Gtsang, but the reason why it is not appropriate in many cases [according to *skar rtsis*] in Amdo with respect to tallying with *rgya rtsis* is that [*skar rtsis*] is accurate [in the following reasons]: because the *lhag chad* of each month is placed individually in the case of *skar rtsis*, it conforms with observation of such things as 4 seasonal points of each year, distinguishing the middle of the month in the 8th and 23rd day of each month, full moon day on the 15th, etc, and since if solar eclipse occurs in this land, it is new moon day according to *nyin zhag* and if only lunar eclipse occurs, it falls on the 15th day according to *nyin zhag*, there is no pervasion, but [they] mostly occurs on the days, and tally with the statement in *Kālacakra* such as being eclipsed at the border of waning and waning phases according to *tshes zhag*, etc., ... especially, there are many occasions that solar eclipsez occur on the 1st day of half month of the Chinese tradition and lunar eclipses occur on the 16th day.

Sum pa Mkhan po is well aware of the difference between *skar rtsis* calendar and Qing Chinese calendar (Ch. *shixianli*) in terms of the day reckoning. The evidence was an eclipse: a lunar eclipse occurred on the 15th *tshes zhag* according to *skar rtsis* calendar. Meanwhile, a solar eclipse occasionally occurred on the 1st lunar day according to Qing Chinese calendar, not on the 30th *tshes zhag* according to *skar rtsis*, in Amdo.[236] Nevertheless, he emphasizes that *skar rtsis* works greatly in Dbus gtsang. Then, he goes back to his topic, i.e., the timing of *gso sbyong* in Amdo in the following way:

> *... dus 'brel gso sbyong yul dus dbang btsan nas rgya rtsis ltar byed dgos na / yar ngo'i gso sbyong bco lnga pa kun rgya mthun bco lnga la byas nas / mar ngo'i bcu bzhi bco lnga pa gang yin kyang bcu drug nas zhag grangs brtsis na cung zad bde yang / de yang skabs 'gar mi 'grig pa 'ong bar snang ngo /*[237]

[236] The differences of lunar dates between Tibet and China are as follows: Tibetan full moon day is on the 15th. However, a synodic month is 29.5 days long. The average length from new moon to full moon is about $14\frac{3}{4}$ days long (not 15 days). Therefore, Tibetan new moon day is not necessarily the first day. However, in the case of Chinese lunar calendar, the new moon day (*shuo* 朔) is always the first day; meanwhile, the full moon day may not be on the 15th. Sum pa Mkhan po is well aware of the difference as seen in the above quotation.

[237] Sum pa Mkhan po (1979c: 79b).

... If *gso sbyong* at a fixed time should be performed according to Chinese calendar due to the power of regional time, it would be a little convenient that after having performed all *gso sbyong*s on the 15th days (*gso sbyong bco lnga pa*) of the waxing phase on the 15th days in accordance with China (Chinese calendar)[238], [we perform] 14th and 15th of the waning phase, whatever, being counted from the 16th (=1st day of the waning phase), but even so, it is not right on some occasions.

He basically embraces the Chinese calendar and maintains the logic of *yul bstun gso sbyong*. However, given the context, he seems to adhere to the day-reckoning of *skar rtsis* without actively receiving the Chinese tradition. His basic stance is as follows: Because the 15th day (*tshes zhag*) is accurate in *skar rtsis*, *gso sbyong bco lnga pa* at the end of the waxing phase is performed without a problem according to *skar rtsis*. The *gso sbyong bcu bzhi pa / bco lnga pa* at the end of the waning phase can be occasionally decided by referring to the Chinese calendar. It may be that because he has no understanding of the day-reckoning system of the Chinese calendar, he cannot present an essential solution for the confusion of *gso sbyong* date caused by the emergence of the Chinese calendar in Amdo. Therefore, the following statement based upon Indian Buddhist concepts and ideas is made by him.

... yang zla 'dzin yod dus su yul der grags pa'i bco lnga'i nyin gso sbyong bco lnga pa byas zin kyang phyi nyin la zla 'dzin byung ba mthong na de'i dus su slar gso sbyong skyar dgos la / de yang 'dul bar mtshan ma mthong na zhes gsungs kyang rtsis (sic. read *rtsi) pas zla 'dzin yod nges ri mos mthong na de'i nyin mo der byas chog la de nyi 'dzin la'ang 'dra bo / de dag gis mtshon pa'i 'dul ba'i bcas bkag gnang gsum sogs kyi phyag len la lar spyi (sic. read spyir) btang dmigs bsal yod kyang / gtso cher sangs rgyas kyis gsungs ltar bya dgos te /... sbrul lo 'di'i rgyal zla'i rgya rtsis nya* (supralinear note: *15*) *la zla sgrib byung ba'i phyi nyin nas bgrangs pa'i bcu drug pa tshes gcig la nyi 'dzin byung pas gso sbyong bya dgos kyang bco lnga las bcu drug pa zer mi 'os sam /*[239]

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[238] "*rgya*" looks to be "*rgya rtsis*" or "*rgya nag.*" It is my interim reading, but I do not understand why "China" or "Chinese calendar" appears here. I think deciding *gso sbyong bco lnga pa* of the waxing phase cannot be a big issue in the *skar rtsis* system. Of course, rgya rtsis calendar can be also referred to together with *skar rtsis* calendar. He may have meant it by the term "*rgya.*"

[239] Sum pa Mkhan po (1979c: 79b).

... Also, although *gso sbyong* was completed on the 15th day as known in the region at the time of lunar eclipse, if lunar eclipse is seen the next day, *gso sbyong* should be performed again at that time. Furthermore, although “when a sign is seen” is stated in Vinaya, it would be fine to do during the day if the certainty of the occurrence of lunar eclipse is seen by values by calculation, and it is also applied in the case of solar eclipse. Even if there are general and special cases in some practices of (making of) rules, prohibitions, and permissions of Vinaya represented by them, but fundamentally, they should be done according to the Buddha’s teaching. ... Because the solar eclipse occurred on the 1st day, the 16th day counted from the next day of the lunar eclipse on the full moon day according to *rgya rtsis*, *rgyal zla* (12th month), snake year (1786 C.E.)[240], *gso sbyong* should be performed, but isn’t it inappropriate to call (it) the (*gso sbyong*) 16th other than the (*gso sbyong*) 15th?

[240] This eclipse has been calculated by A kya. For the calculations, see chapter 4. The date of the 12th month in the year *shing sbrul* (1786 C.E.) according to *grub rtsis*, *byed rtsis*, and Qing Chinese calendar is as follows:

Gregorian date	Jan, 1, 1786	2	3	4	5	6	7	8	9	10	11	12	13	14	15
grub rtsis	1785/12/1	2	3	4	5	6	8	9	10	11	12	13	14	**15**	16
byed rtsis	12/1	2	3	5	6	7	8	9	10	11	12	13	14	**15**	16
Chinese date (year: *yisi* 乙巳)	12/2	3	4	5	6	7	8	9	10	11	12	13	14	**15**	16

*** Chinese calendar: 12/1 = Gregorian date: Dec, 31, 1785 = *grub rtsis* 1785/11/30 = *byed rtsis* 1785/11/30.

Gregorian date	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
grub rtsis	17	18	19	20	21	22	23	24	25	26	27	28	28	**29**	1/1	1/2
byed rtsis	17	18	19	20	21	22	23	24	25	26	27	28	29	**30**	1/1	1/2
Chinese date	17	18	19	20	21	22	23	24	25	26	27	28	29	**30**	1/1	1/2

We see here that there is a problem for the calculation of the solar eclipse: there is no 30th day in *grub rtsis*, and this must have caused a problem in performing *gso sbyong* as mentioned by Sum pa Mkhan po. In conjunction with this, the following may be raised: it seems that the *Mā yang rgya rtsis* (see chapter 4) was not used for eclipse calculation up to the 1780s in Amdo. The discrepancy between *rgya rtsis* and *skar rtsis* dates was perceived, but if *Mā yang rgya rtsis* was ever used or existed, Sum pa Mkhan po and Ngag dbang nyi ma could have mentioned that there is no problem in terms of date and eclipse occurrence when the eclipse is calculated by *Mā yang rgya rtsis*. But they just mention the difference between the dates. I guess that this may mean that eclipse calculations according to *skar rtsis* were exclusively used at that time when they exchanged the letters.

He presents a "paradoxical" idea (according to Deleuze's sense) that affirms both the performance of Indo-Tibetan vinaya and that of *gso sbyong* according to Chinese calendrical date by placing the former under the category of general cases (= *zhag mi thub*) and the latter under the category of special cases (= *yul bstun gso sbyong*). Of course, as expected from Tibetan scholars, the superiority was given to the former. His interpretation is quite a common approach observed in making sense of different astronomical knowledge sources.

Another example, which is based upon the same dyadic relationship between *zhag mi thub* and *yul bstun gso sbyong* and which also shows the relationship between *gso sbyong* and an eclipse in Amdo is as follows: Gser tog clearly says that an eclipse influences deciding the performance of *gso sbyong* in the following way:

> *... zla re bzhin gyi nya dang zhag thub mi thub kyi gnam gang ngam nyer dgu la dus 'brel gyi gso sbyong / de la 'dul ba las / spyir btang dmigs bsal du ma gsungs shing / khyad par zla bshol ni rgyal po'i rjes su 'brang bar bya'o / zhes dang / mtshan ma byung na gso sbyong bskyar bar bya'o / zhes gsungs pa la brten nas / a mdo tsong kha'i yul 'dir rgya nag ser rtsis kyi zhan bshu' ste rī thu*[241] *ltar zla ba che chung dus mtshams nyer bzhi sogs de la bstun pa'i phyir / sngar gyi phyag srol gyi rgyun ni dper na hor zla dang po'i tshes gcig nas drug pa'i bco lnga'i bar dang / de nas zla ba bcu gnyis pa'i gnam gang bar / nyin zhag grangs kyis thub mi thub brtsis nas gso sbyong mdzad cing / de'i tshe nyin zhag dang tshes zhag sna ma mnyam pa'i dbang gis / gza' 'dzin nam nyi 'dzin byung na snga nyin gso sbyong byas yod na nyin 'dir slar yang bskyar ba dang / byas med na nyin 'dir gso sbyong byas te phyi nyin nas zhag grangs bgrang zhing / gal srid mtshan ma ma byung na / drug pa'i bco lnga dang / bcu gnyis pa'i gnam gang ngam nyer dgu la zhag bco lnga long ma long (sic.* read *longs ma longs) gang yin yang dmigs bsal dbang btsan par byas te gso sbyong bco lnga pa mdzad pas lo zla khyud 'khor la thub mi thub kyi gso sbyong nyin zhag grangs bzhin mdzad pa yin / 'on khyang deng sang gso sbyong de ltar mdzad kyin med par bshad mkhan mang yang /... .*[242]

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[241] It seems to mean almanac / calendar (T. *li tho / lo tho*) given the previous term '*zhan bshu'*. Guo's (1986: 186) rendering *litu* (歷圖) looks to be correct.

[242] Gser tog (1982: 234). For Chinese translation, see Guo (1986: 186).

Regarding the *gso sbyong* at a fixed time on the full moon day and on the new moon or on the 29th by *zhag thub* or *zhag mi thub* every month, relying upon the Vinaya stating many special cases in general and [stating] that as for leap month, specifically, *rgyal po*[243] should be followed and [stating that] *gso sbyong* should be repeated if a sign occurs, in order to accord with such as big and small month (30 day month and 29 day month respectively) and 24 *jieqi*s (節氣),[244] etc. according to the *shixianshu* (T. *zhan bshu'* / Ch. (*shi*)*xianshu* (時)憲書))[245] almanac of Chinese *ser rtsis* here in Tsong kha district, Amdo, the continuity of the previous system, for example, is as follows: *gso sbyong* is performed after calculating *thub* or *mi thub*[246] by the numbers of *nyin zhag* from the first day of the first *hor zla*[247] to the 15th day of the sixth *hor zla*, and then, up to the new moon day of the 12th *hor zla*, and at that time, because of the imbalance between the *nyin zhag* and *tshes zhag*, in case that a solar eclipse occurs: if *gso sbyong* was performed on the previous day, it is repeated again, and if it was not performed, it is performed on that day and the day numbers are counted from the following day, and if a sign does not occur, *gso sbyong* is performed on the 15th day (T. *gso sbyong bco lnga pa*) on the 15th day of the sixth *hor zla* and on the new moon or on the 29th day of the 12th *hor zla* by the power of the special case, regardless of whether it is sufficient to be the 15th day or not. In doing so, in the entire year month, *gso sbyong* of

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[243] This seems to be *Rgyal po'i gzhung* mentioned in Sum pa Mkhan po (1979c: 94a). Or, *rgyal po* = 16, the 16th day? This does not make sense.

[244] The 24 *jieqi* (節氣. seasonal points. T. *dus mtshams nyer bzhi* / *dus tshigs nyer bzhi*) denotes Chinese 12 *jieqi* 節氣 (T. *dbugs*) and 12 *zhongqi* 中氣 (T. *sgang*). See Tshe tan zhabs drung (2007a: 341-6), Henning (2007: 354-6). For a general understanding of the Chinese system, see Sivin (2009: 79-81). In current *lo tho*, there are two *sgang*-s and two *dbugs*-s. Firslty, the *rgya sgang* and *rgya dbugs* are either the same with or very close to the Chinese 24 *jieqi*, which date back to Mtshur phu Rgyal tshab Chos dpal bzang po's (1766-1820) *rgya rtsis gsar 'gyur* (new translations of Chinese calculations / *rgya rtsis*) according to Chos kyi rgyal mtshan (1985: 144a) [= (1986: 125a) = (2004: 140a)]. For the calculation method, see Chos kyi rgyal mtshan (1985: 96b-101b) [= (1986: 82b-87a) = (2004: 88b-93b)]: It is verified that the method which has been adopted in current *lo tho* published by Lha sa sman rtsis khang (see Bod ljongs gnam rig skar rtsis rig gzhung tshogs pa (1985: 153-5)) is based upon Chos dpal bzang po's values and methods. Secondly, the *bod sgang* and *bod dbugs* are not related to the Chinese *jieqi* but to the Tibetan intercalation. Their positions are closely tied to the intercalation method in which *mda' ro lhag ma* 48 and 49 indicate leap month in the *Phug* system. It is safely assumed that the change of the values of the *mda' ro lhag ma* into 48 and 49 possibly in the middle / late 17th century is tied to the introduction of the concept *sgang* and *dbugs*. See Janson (2014: 57, n. 68).

[245] *Shixianshu* is an almanac based upon *shixianli* which is Qing Chinese calendrical astronomy of Western origin. For more information, see chapter 4. Sivin's (2009) rendered it the 'temporal pattern system.'

[246] *Thub mi thub* means *zhag thub / zhag mi thub*.

[247] For *hor zla*, see Schuh (2008: 216 ff), Schuh (2012: 1647-8).

> *thub* or *mi thub* is performed according to the numbers of *nyin zhag*. However, nowadays, there are many who speak that *gso sbyong* is not performed as such, but ... .

The issue of the performance of *gso sbyong* on the 29th day of the 12th month was mentioned in the above passage. Concretly speaking, if the 29th day is the 14th *nyin zhag*, not the 15th on a fortnightly basis, it contradicts the *gso sbyong bco lnga pa*. The problem may not be simple because it means a serious threat to the logic of *zhag mi thub*, which was interpreted to buttress the performance of *gso sbyong* as speficied in vinaya texts. The solution looks as follows according to the above praragraph from Gser tog: the logic of *zhag mi thub* is still effective, but an exception should be included: the *gso sbyong* is fine to be performed on the 29th (= 14th *nyin zhag*) in the case of the 12th month. As a matter of fact, the exception is a fatal counter-example that ruins the concept of *zhag mi thub*. Nevertheless, Gser tog's idea is to strengthen and solidfy the religious practice of *gso sbyong* based upon *skar rtsis* day-reckoning system by setting up an exception as Sum pa Mkhan po did. Because Tibetans' priority concern in the performance of *gso sbyong* is essentially the descriptions in Vinaya texts, the exceptions were interpreted to be compatible with them.

Another aspect which threatens the accuracy of *tshes zhag* in *skar rtsis* was that solar eclipses occasionally occurred on the 1st *tshes zhag* (= on the 1st lunar date as in Chinese lunar calendar), not on the 15th *tshes zhag* on a fornightly basis (= 30th *tshes zhag*) as in Tibetan calendar. For example, a solar eclipse was predicted to occur on 1786/1/1 according to Chinese calendar. The date also falls on 1786/1/1 according to *Phug pa grub rtsis* calendar. Such examples must have been a threat to the performance of *gso sbyong* because they mean that the *zhag mi thub* based upon the accuracy of *tshes zhag* is not always rigorously applied.

Given the aforementioned Sum pa Mkhan po and Gser tog, the following fundamental points regarding the performance of *gso sbyong* may be raised in conjunction with eclipse phenomena: In the case of the Chinese calendar, the new moon day is more accurate, while in the Tibetan lunar calendar, the full moon day is more accurate. Thereby, the former is more accurate than the latter in terms of the correlation between the date of a solar eclipse (= the first lunar day (= new moon day) in the Chinese calendar) and its real occurrence. By the observation of the ocurrence of a solar eclipse according to the Chinese calendar, it was easily recognized that *skar rtsis* occasionally disclosed a limitation in day reckoning. However, it is not likely that the fact simply implied the accuracy of the Chinese system because, in the case of a lunar eclipse, the date according to *skar rtsis* must have been more accurate than the Chinese one (see also Sum pa Mkhan po above (1979c: 93b-94a)) in terms of the correspondence between the *tshes zhag* and real occurrence of a lunar eclipse. Under such circumstance, Tibetan scholars figured out a solution by accommodating both the Indian Vinaya texts and the Chinese calendar for the performance of *gso sbyong*. Given Sum pa Mkhan po (1979c: 90b),[248] it is certain that

[248] See again Ngag dbang nyi ma's questions in Sum pa Mkhan po (1979c: 90b) translated on above page 91. Further, see A kya's calculation in chapter 4. Even if there is no textual basis, the reason why A kya calculated the solar eclipse at 1785/12/30 may be related to the performance of *gso sbyong* on the same date. Let me use A kya's calculation to explain the above Gser tog's passage. In the *Phug pa grub rtsis* calendar, 1785/12/7 and 1785/12/30 do not exist (*chad*) and 1785/12/28 is doubled (= *lhag*). 1785/12/1 to 1785/12/16 are 15 *nyin zhag*-s and 1785/12/17 to 1785/12/29 are 14 *nyin zhag*-s. There are 29 *nyin zhag*-s in total. It follows then that the *gso sbyong bco lnga pa* on a fortnightly basis is jeopardized in that month. Should *gso sbyong* be done on 1785/12/29? The date falls on the 14th *nyin zhag* on a fortnightly basis, which means that the *gso sbyong bco lnga pa* cannot be followed. In addition, a solar eclipse was predicted on 1786/1/1

the emergence of the Chinese calendar in Amdo and the verification of its accuracy by the date (= new moon day) of solar eclipses influenced Tibetan interpretation of the performance of *gso sbyong*. However, it is also certain that they still adhered to Buddhist concepts and interpretations such as vinaya specifications, the difference between *tshes zhag* and *nyin zhag*, *zhag mi thub*, etc. From a different angle, eclipse phenomena played a pivotal and crucial role for the religious practice of *gso sbyong* in Amdo, being combined with the Chinese calendar which showed coherency in terms of the correspondence between date and the occurrence of a solar eclipse. Lastly, the following fact needs to be indicated: it is verified from the above passages from Sum pa Mkhan po and Gser tog that *gso sbyong* was practiced upon the occurrence of eclipses in the 18th century Amdo. — This tradition does not exist any more as far as I know. The last line in the above passage from Gser tog (see above pages 106-8) may mean that it already vanished. — As a result, accurate predictions and calculations of eclipse combined with observation of real eclipse

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according to Qing Chinese *shixianli* calendar (the date also falls on 1786/1/1 according to *Phug pa grub rtsis* calendar). *Gso sbyong* is supposed to be performed when an eclipse occurs. —The accuracy of *tshes zhag* for the timing of the solar eclipse was proven to be problematic in this case. It should be stressed again that 15th and 30th *tshes zhag* are tied to the occurrence of an eclipse as well as to the performance of *gso sbyong*. — Then, when to perform *gso sbyong*? Only on 1786/1/1? In contrast with their serious frame of thinking and religious concern, their answers look simple. For example, both Sum pa Mkhan po and Gser tog suggested that the *gso sbyong* should be performed on both day by setting up a special case for 12/29 (according to *Phug pa grub rtsis* calendar. See below table). The solutions given by them may reflect the general approach at that time in Amdo. Let us keep eyes open wide and correct materials which substantiate or invalidate my conjecture.

Gregorian date	Jan 29, 1786	Jan 30, 1786	Jan 31, 1786
grub rtsis	**1785/12/29**	**1786/1/1**	1786/1/2
byed rtsis	**1785/12/30**	**1786/1/1**	1786/1/2
Chinese date	**1785/12/30**	**1786/1/1**	1786/1/2

phenomena and research into a neighboring tradition must have been an indispenpensable part for the practice of *gso sbyong*.

More research is needed, but given the above passages from Sum pa Mkhan po and Gser tog, the following scenario may be suggested regarding the religious meanings of an eclipse in conjunction with *gso sbyong*: firstly, an eclipse was accompanied by religious practice in Tibet. Buddhist rituals including *gso sbyong* were performed when eclipses occurred. Secondly, in the local unfolding of the buddhist practice *gso sbyong* in the 18th century Amdo, there existed the mismatch between the logic of *zhag mi thub* and the Chinese calendrical system, and eclipse phenomena were manifest evidence of the disaccord. As a result, Tibetan astronomers set up exceptions by the logic of *yul bstun gso sbyong*, which is an example to show that an eclipse influenced the decision of the religious performance. Essentially, the whole process was tied to the issue of the accuracy of *tshes zhag/ gza'* values in *skar rtsis*.

Let me recapitulate the second religious meaning due to its gravity in the religious practice and the accuracy of *skar rtsis*. First, for the *gso sbyong* date in accordance with *skar rtsis*, the Tibetan traditional justification is *zhag mi thub* based upon the imbalance between *tshes zhag* and *nyin zhag* whose textual basis is the Indic *Abhidharma* texts. In the exegesis, the accuracy of *tshes zhag* in the *skar rtsis* system is a central idea. Second, however, upon the emergence of the Chinese calendar in Amdo, the different dates between *skar rtsis* and the Chinese calendar, especially in the case of new moon, were occasionally witnessed together with the occurrence of solar eclipses in accordance with the Chinese date. Third, under such situation, the following issues became critical for the practice of *gso sbyong*: how to make sense of the Indian vinaya in the district of Amdo near to China where the Chinese date looked more accurate as seen from the occurrence of solar eclipses? Can the Chinese date be embraced for the performance of the religious rite of *gso sbyong*? A solution was presented in the writings of Sum pa Mkhan po, Gser tog, etc.. As expected, Sum pa Mkhan po first defended the time-honored Tibetan tradition of *skar rtsis*. He stressed that the *gza'* value of *skar rtsis* is accurate in Dbus gtsang (mainland Tibet), even if it may be less accurate than the Chinese calendar in Amdo. Of course, he did not simply ignore the Chinese calendar evidenced by the occurrence of solar eclipses. For a solution to accommodate both *skar rtsis* and the Chinese calendar, he set up an exception for the cases which are beyond the boundary of the logic of *zhag mi thub*, suggesting a special case of *yul bstun gso sbyong*. In other words, he embraced the Chinese calendar for the performance of *gso sbyong.* The relationship between an eclipse and *gso sbyong* is dramatically witnessed in the coordination between the religious practice in the Indian Vinaya texts and the calendrical viewpoints seen in his suggestions: an eclipse proves the accuracy of an astronomical system and thereby influenced the religious practice. Of course, no antithetical relation between astronomy and vinaya was established. Also, vinaya assumes the superior position, being combined with *skar rtsis* calculations supported by the *Kālacakra*. Later, Gser tog follows Sum pa Mkhan po's suggestions. The former may have read the letter exchanges between the latter and Ngag dbang nyi ma, given the similarity of the ideas unfolded by the former (See above pages 106 ff). Or, it is highly possible that the ideas were common among the scholars in Amdo at that time. In other words, Sum pa Mkhan po probably followed the contemporary wide-spread opinions for the observance of *gso sbyong* in Amdo.

Before ending this chapter, let me go back to the issue of paradox: while *zhag mi thub* is based upon belief in the accuracy of *tshes zhag* in *skar rtsis*, *yul bstun gso sbyong* is a counter-example showing that *zhag mi thub* is not always true. The *yul bstun gso sbyong* is a corollary from the observation of eclipse phenomena in accordance with the Chinese calendar. I suggest that the affirmation of *zhag mi thub* and *yul bstun gso sbyong* is a paradox in a Deleuzian sense. The association and equation between the Indo-Tibetan calendar and the Chinese calendar and the clear sense of the malfunction of the *zhag mi thub* and the ensuing establishment of the exceptions embracing the Chinese calendar may mean that Tibetan astronomers tacitly or overtly have accepted the conflictions and contradictions when making sense of their astronomical calculations. Further, by the affirmation and approval of both, they have made sense of the different traditions and methods while still mainly adhering to their own tradition. With the superiority of Indic Vinaya and *skar rtsis* calculations based upon the *Kālacakra*, the Chinese methods and calculations worked auxiliarily.

PART II.

AN INCREASE IN THE ACCURACY OF ECLIPSE CALCULATIONS

CHAPTER THREE

THE *KĀLACAKRA* APPROACHES TO KNOWLEDGE

INTRODUCTION

Solar and lunar eclipses have religious significance in Tibetan society, as seen in chapters 1 and 2. Thus, it was necessary for Tibetans to accurately predict them. In the following section, I will focus on the approaches and methods that Tibetans employed to predict eclipses. Textual and non-textual sources have contributed to the accuracy of eclipse prediction. Due to the religious authority of the *Kālacakra*, eclipse prediction is arranged in a religious context despite its scientific premise.[249] The approaches in this chapter are inextricably tied to eclipse-calculational techniques, which will be tackled in chapter 4.

[249] I divide knowledge sources in *skar rtsis* into "textual" and "non-textual." "Textual" refers to Buddhist texts. In the conception of *Kālacakra* adherents, the major textual source is the *Kālacakra* to which the utmost authority is given. The other Buddhist texts may be regarded as not as authoritative as the *Kālacakra*. I use the term "non-textual" to denote knowledge obtained from astronomical observations, empirical data, discussions and debates, other traditions such as Chinese astronomy/ astrology, etc. The "non-textual" sources may have nothing to do with Buddhism, but they are not necessarily non-buddhist. Moreover, it should be noted that the "textual" and "non-textual" sources are not opposed, because both are simultaneously affirmed through the superiority assigned to the textual *Kālacakra*. The hermeneutics will be clarified throughout this chapter.

1. KNOWLEDGE DEPICTED IN BUDDHIST TEXTS

KNOWLEDGE IN BUDDHIST TEXTS FOR ECLIPSE CALCULATION

The most basic step in eclipse calculation is to judge eclipse possibility. True/ apparent position (longitude) of the sun and the moon and the position of the nodes are necessary.[250] The *Kālacakra* indicates basic techniques for eclipse calculation such as true longitude of the sun and moon, nodes (*sgra gcan*), etc.[251] Geometric and geographical knowledge make the calculations accurate, but the *skar rtsis* calculations are far from geometric.[252] Although it is certain that the *Kālacakra* is somewhat based upon Indic

[250] As described by Sivin, the position of apparent conjunctions, i.e. proximity to the lunar nodes, are pivotal for accurate eclipse calculation. See Sivin (2009: 312): "Accurate prediction of time and magnitude depend on successfully incorporating a number of factors into an eclipse theory. One is the position of apparent conjunction. This is in turn based on knowledge of the apparent lunar and solar motions: solar equation of center, and lunar equation of center. Another important variable is proximity to the lunar nodes. The nodes are the intersections of the ecliptic and the lunar orbit, where the right ascensions and declinations of the sun and moon are equal." The nodes are the two points (the ascending node and the descending node) where the moon's orbit and the ecliptic intersect. In order for an eclipse to occur, the distance between the moon and the nodes at new moon and full moon should be close enough. Concretely, the lunar eclipse occurs: 1) at full moon and 2) when the moon near one of the nodes. The solar eclipse occurs: 1) at new moon and 2) when the moon is near one of the nodes.

[251] See Henning (2007: chapter 5).

[252] For example, knowledge on parallax, which diminishes the altitude of a celestial body, is crucial for solar eclipse calculations. They concern lunar horizontal parallax (diurnal parallax; horizontal parallax is a special case of diurnal parallax), i.e. the angular difference between the observation from the center of the earth and that from the surface of the earth at the observer's position. It is maximal when the moon is on the observer's horizon. Nearly all astronomical books describe this. To illustrate some, see Evans (1998: 253-4); for the Ptolemaic approach, see Pedersen (1974: 203-35) in ancient astronomy. For basic explanations, see Schmeidler (1994: 24-5), and Duffett-Smith and Zwart (2011: 83-8, 176-7). Parallax calculation is pivotal for a solar eclipse is because it influences the possibility of an eclipse. Simply put, eclipse limit is

geometric knowledge, it is difficult to determine which geometric bases were adopted in the system.[253] Rather, the expressions in it are arithmetic in nature. Concretely, the *Kālacakra* specifies the calculation method of the position of the sun and moon in the *Laghukālacakra* and the *Vimalaprabhā* I. 29-38.[254] Based on this, Tibetans formulated the algorithm for the sun's true motion. As for the apparent position, understanding of parallax is necessary, but the *Kālacakra* is not a good textbook for this. Moreover, there is no clear division between ecliptic motion and the orbit of the moon in the *Kālacakra.* In

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determined by apparent latitude of the moon, which changes via different parallax values. It also influences the time of mid-eclipse, magnititude, etc. Mid-eclipse timing by calculation does not agree with apparent conjunction because of parallax. In the case of magnitude, it is influenced by the apparent semi-diameter of the moon, which changes according to the distance between the moon and earth, refraction, etc. Taken together, parallax is one of the most important factors that should be incorporated into real calculations of solar eclipses. However, in the case of *skar rtsis*, there is no evidence that parallax was understood and used. For example, the timing of the occurrence of eclipses is fixed; empirical corrections, not parallax based upon geometry, have been applied. Of course, there is a Tibetan method in which parallax was applied for solar eclipse calculation. See chapter 4 for my preliminary study on parallax applied in the *Mā yang rgya rtsis* (= the duplication of the eclipse algorithm included in the *Lixiang kaocheng*). Another example: in modern astronomy, the calculation of times of sunrise and sunset, which is related to decide the time of eclipse occurrence, requires the declination of the sun and celestial latitude of the observer. Although there have been studies into times of sunrise snd sunset in *skar rtsis* astronomy, they are not based upon geometric knowledge of such kind. They are mostly conjectured to be based upon empirical knowledge according to each region. This topic may require systematic research. Moreover, the points I raise here are connected to the criticism in the preface of *Tngri-yin udq-a*. See my Appendix II.

253 Ōhashi (1986: 635-7), (1991), (2000: 354-60) points out that the equation of the center of the sun and moon and the epicyclic correction of planets, are close to the Indian *Ārdharātrika* school by comparing Indian works with Bu ston's *Mkhas pa dga' byed*. However, things may be more complex. Regarding errors in the *Lāghukālacakra* in terms of the equation of the center of the sun within a bigger frame of Indian astronomy, see Pingree (2001: 659-60).

254 See Henning (2007: 228-70). Modern research into chapter I of the *Laghukālacakra* and its commentary *Vimalaprabhā* include Toganoo (1989): *Laghukālacakra*, I. 1-33/ *Vimalaprabhā*, I. 1-148 (some verses are intermittently not translated), Banerjee (1959): *Laghukālacakra*, I. 1-169, Newman (1987): *Laghukālacakra* / *Vimalaprabhā*, I. 1-27, I. 128-170. Henning (2007): *Laghukālacakra* / *Vimalaprabhā*, I. 26-52. However, a word of caution: except for Henning (2007), these authors have no knowledge of Indian and Tibetan astronomy. Thus, their translations may not be reliable.

other words, there is no acknowledgement of the fact that the sun and moon travel nearly on the same path. Therefore, the implication is that an eclipse is not caused by the occultation of the earth and moon respectively, but by the motion of Rāhu. In other words, the virtual planet of Rāhu (T. *sgra gcan.* ascending node (*sgra gcan gdong*) and descending node (*sgra gcan mjug*)) are used to judge the distance between themselves (*sgra gcan gdong* and *sgra gcan mjug*) and the sun and moon, to explain the occurrence of an eclipse.[256] See verses *Laghukālacakra* and *Vimalaprabhā* I. 39, I. 52. The period of Rāhu is 230 lunar months (*tshes zla* = 6900 *tshes zhag*). It means 0.234782608 *yul gyi chu tshod* (= $0^{k}0^{q}14'0''12'''$ (23)) per *tshes zhag*. [258]

In the textual "series," the *Kālacakra* is a theorical basis. Chapter I in the *Laghukālacakra* is intimately connected to the other chapters—converging toward religious practice while showing a clear sense of the period of planets under the scheme of outer – inner – other (T. *phyi nang gzhan gsum*)[259]. Since it is basically a religious text

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[256] The use of the term Sgra gcan (Rāhu) in ancient Asian astronomy—including India, central Asia, China, etc.—is complex. To briefly describe it in the Tibetan context: In Indian astronomy, generally, the ascending node is called Rāhu; the descending node is Ketu. For example, Yabuuchi's research into the *huihuili* in China, van Dalen tr. (1997: 26): "As far as the points of intersection of the ecliptic and the inclined lunar orbit are concerned, following terminology of Indian astronomy, it was customary to distinguish between Rāhu (Ch. *Luohou* 羅睺) as the ascending node and Ketu (Ch. *Jidu* 計都) as the descending node." But in Tibetan astronomy/astrology, the ascending node is called Sgra gcan gdong (head of Rāhu) and the descending node is called Sgra gcan mjug (tail of Rāhu). Another planet—in Tibetan conception— Mjug ring (comet) is Ketu. In other words, Ketu has nothing to do with node or eclipse.

[258] $1620^{q} \div 6900 = 0.234782608$. The equivalent value $0^{k}0^{q}14'0''12'''$ (23) is everywhere in *skar rtsis* texts. For example, see Huang and Chen (1987: 228), Henning (2007: 96, 271-3).

[259] The *Kālacakratantra* is composed of the following interrelated three parts: *phyi* (*phyi'i dus 'khor*), which means outer time cycle of the cosmos; *nang* (*nang gi dus 'khor*), which means inner time cycle of a person;

that uses astronomical phenomena for the explanation of tantric practice in an arcane and esoteric way, concrete details and methods for astronomical calculations may not be a major concern. Aside from the *Kālacakra*, even if we extend the scope of investigation on astronomical knowledge to Buddhist texts, there may exist no remarkable difference. It is difficult to find theoretical and calculational expositions for astronomical calculations in general, and eclipse calculations in particular, in other Buddhist texts. Even if relevant information is found, religious interpretations are dominant.

Next, by using Ku sri skyabs's (?-?) religious hermeneutics on the virtual planet *sgra gcan*, let us see how Tibetan astronomers read astronomical phenomena from a Buddhist perspective. He presents three classifications in terms of *buddhavacana*: five *neyartha* (*drang don*) texts, two *thun mong ba* texts, and three *nītārtha* (*nges don*) expositions.[260] Firstly, mythical accounts on *sgra gcan* in the following texts are classified as *drang don*: (1) *Dran pa nye bar bzhag pa* (S. *Smṛtyupasthāna*), (2) Thar pa Lo tsā ba Nyi ma rgyal mtshan's (13th c. ~ 14th c.) later translation of the *Nyi zla'i mdo*[261], (3) *Myang 'das mdo* (S.

and *gzhan* (*gzhan gi dus 'khor*), which is associated with the stage of generation (T. *bskyed rim*) and that of perfection (T. *rdzogs rim*).

[260] *Thun mong ba* and *thun mong ma yin pa* are generally seen in Tibetan Buddhist exegeses on the interpretation of sūtras and tantras. For example, Kapstein (1988: 151) explains the differentiation between *thun mong ba* and *thun mong ma yin pa;* their subdivisions, *drang don* and *nges don*, are used as a hermeneutic tool in Kong sprul's *Shes bya kun kyab*. In Ku sri skyabs's case, I do not know what the middle *thun mong ba* has in relation with the first *drang don* and third *nges don*. At any rate, he uses the Buddhist hermeneutics for making sense of and justifying the supreme authority of the *Kālacakra*.

[261] It means the *Nyi ma'i mdo* (S. *Sūryasūtra*) and the *Zla ba'i mdo* (S. *Candrasūtra*). See *Bka' 'gyur Dpe bsdur ma*, vol. 34: 832-3 and vol. 34: 836-7 respectively. For the latter, see the Sde srid (2010: 64).

Mahāparinirvāṇa sūtra), (4) *Rgyud bla ma, and* (5) *Dgongs can bya rgyud gra lnga* (*Gzungs gra lnga* ?). They are "the way of explanation of being related to *kun rdzob bden pa* (S. *samvṛtisatya*. conventional truth)." (*kun rdzob bden sbyar bshad tshul*).[262] Next, two *thun mong ba* texts include: (6) *phyi rol rig byed gtam rgyud*, and (7) *Yan lag brgyad pa.*[263] They are "... we don't consider the external world as true, which is explained in the texts, which has been refuted in the *Tshad ma rnam 'grel*, etc." (*... phyi rol gzhung bshad bden pa ru / mi 'dzin tshad ma rnam 'grel sogs nas bkag* /). Lastly, the three *nges don* expositions are as follows: (8) "according to outer, ... ultimate truth" (*phyi ltar ... ... gnas lugs*), (9) "when combined with inner ... explained under the category of *rtsa dkar* = *zla ba*, *rtsa nag po* = *nyi ma*, and *rlung rgyu* (wind channel; moving wind) = *sgra gcan*." (*nang dang sbyar na ... rtsa dkar zla ba nag po nyi ma dang / rlung rgyu sgra gcan rigs su bshad pa yin* /), and (10) "... connected with yoga of the developing stage (*bskyed rim*) and the perfection stage (*rdzogs rim*)" (*bskyed rdzogs rnal 'byor dang sbyar ...*).[264] They are "the way of apprehending by

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[262] Buddhism differentiates two levels of truth, i.e. *samvṛtisatya* (*kun rdzob bden pa.* conventional truth) and *paramārthasatya* (*don dam bden pa.* ultimate truth).

[263] It means Vāgbhaṭa's (7th c.) *Aṣṭāṅgahṛdayasaṃhitā* (T. *Yan lag brgyad pa'i snying po bsdus pa*).

[264] Ku sri skyabs (1979: 33b-35a). For a similar description of Rāhu which appears in Tibetan literature, see also the Sde srid (2010: 52-64). Ku sri skyabs must have read the Sde srid (2010). Ku sri skyabs (1979) is included together with Brag dkar rta so Chos kyi dbang phyug's (1775-1837) text Chos kyi dbang phyug (1979: 75-89) under the modern title, *Tibetan Rtsis Texts.* The editor writes in the preface that the writing in it "is apparently from Western Tibet and represents a tradition that passed through Brag dkar rta so Chos kyi dbang phyug." Even if this is the case, we do not know who predates who between Ku sri skyabs and Chos kyi dbang phyug. For future researchers, let me briefly mention the colophon in Chos kyi dbang phyug (1979: 88-9): Chos kyi dbang phyug (1979) was written in 1824/3/15 at Le'u dgon nges don dar rgyas gling in Mang yul (Mnga' ris) at the request of Bag dro, who was called "astronomer, a nephew of the throneholder of the monastery of Dpal sding, Mdo chen po (?))" (*dpal sding gdan sa pa mdo chen po'i gdung dbon rtsis rig 'dzin pa*).

combining the three, i.e. outer, inner and other in the great secret *Kālacakra*, the essence of *nītārtha*." (*nges don snying po gsang chen dus 'khor lor / phyi nang gzhan gsum sbyar 'dzin tshul*). In other words, the *phyi nang gzhan gsum* of the *Kālacakra* are *nītārtha*. Ku sri skyabs (1979), which is a *skar rtsis* text based upon the Sde srid in many respects, is filled with religious content. It is also clear that such information is not of service for real eclipse calculation. These types of religious orientations and contexts in the *Kālacakra* and Buddhist texts have been described and may be presupposed. However, in real calculations, Tibetan astronomers have no choice but to go beyond them.

2. KNOWLEDGE FROM NON-TEXTUAL SOURCES

Religion-based, and thereby meager, interpretations for real eclipse calculation in the Buddhist texts have been inevitably followed by the adoption of non-textual elements. In most cases, no theoretical aspects such as the movement of the sun and moon, *sgra gcan*, etc are considered. Instead, the focus is on the improvement of the accuracy of eclipse calculation within the given frame of the *Kālacakra* calculations. My following observations on them, albeit periodically broad in the beginning of each source, will narrow each down to the 18th century eclipse calculation when possible.

2.1. *MYONG BYANG* (A NOTE BASED UPON OBSERVATION): ASTRONOMICAL OBSERVATION AND CRITICISM

Firstly, corrections through astronomical observations have been made. As mentioned by Petri and Schuh, astronomical observation may have not been active in Tibet. Schuh argues that since the *Kālacakra* system was officially established in the 13th century in Tibet, the Tibetan system has not been combined with real observations and criticism. I only partly agree with Schuh's point.[265]

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[265] For the modern appraisal of the Tibetan astronomical observations, see Schuh (1974: 559-60, 562-3). Also see Schuh (1973a: 20): "... konkrete, systematische Beobachtungen des Sternhimmels und der Planetenbewegungen von Seiten tibetischer Astronomen nur in geringem Maße durchgeführt worden sind und dass solche Beobachtungen für die Entwicklung der Astronomie in Tibet nicht von großer Bedeutung gewesen sein können." Before him, Petri also made similar comments. See Petri (1967: 161): "Geometry is never made use of; nor do we read about actual observations except some very simple eclipse phenomena and one interesting remark about a comet ..." Petri should be used cautiously. He is a specialist in modern astronomy, indeed, but he is not a specialist in the field of Indo-Tibetan astronomy. He relied upon very limited, contemporary, translated materials on Indian astronomy and made arbitrary decisions. Information in his writings is outdated and is historically too simplified and untenable. Also, some of his arguments remain as hypotheses. For example, he presents hypotheses on precession in this way: Petri (1966: 105): "Für das *Kālacakra* gilt festzuhalten, dass neben einer "solaren" Periode von 21600 (*Laghukālacakra* 22/23) eine "planetare" von 24000 (*Laghukālacakra* 87; Bhukti des Planetenjahres) vorkommt, die beide in der zeitgnössischen indischen Astronomie für die Präzession auftreten. Die Erscheinung der Präzession selbst ist nirgends explicite dargestellt." The reason why I mention Schuh and Petri is as follows: They may be right, but it should be stressed that the observations of eclipse, equinox and solstice have been made continuously. Firstly, regarding eclipses, see Schuh (1973a: 20, n. 83): "Abgesehen von der Bestimmung der Sonnenwenden anhand des Gnomon ... liegt nur ein einziger Hinweis über systematische Beobachtung der Mondbahn im Zusammenhang mit der Berechnung von Sonnen- und Mondfinsternissen vor." As Schuh himself says, eclipse observation is a big part of Tibetan astronomy. I also present some examples I found. Secondly, regarding the observation of equinoxial and solstitial points, see below note 553. In particular, Henning (2007: 315-6) presents 'Gos Lo tsā ba's observation on the length of day and night, and summer and winter solstices, and says that it contributes to the creation of the accurate longitude of the sun in his system. Moreover, we can obtain more information on Tibetan observations through the brief modern research made by Tshul khrims chos 'byor et al. (1983), Zhou et al. (1995). Thus, I think we do not need to jump to the conclusion that Tibetan astronomical observation was not significant in the development of the field. We can collect as many case studies as possible. Another point I raise is the role of observation. For example, we should ask why Tibetans were so eager to accurately predict eclipses.

In fact, observations have been made continuously and have been recorded as *myong byang.*[266] For example, Sum pa Mkhan po's (1979c) letters show astronomical observations accumulated from his predecessors.[267] Among them, his correspondence with the Paṇ chen lama in 1779 C.E. presents his opinions on the correct *rtsis 'phro* of comets (*du ba mjug ring gi rtsis 'phro rnam dag*) in the following way.

> *drang srong du ba can kho bos 'ga' zhig mthong ba ni / sngar rab drag lcags stag la mjug ring du phod ring po can mnga' ris su shar zhes pa dang mtshungs par / a mdor yang rab nyi'i chu phag la du ba shin tu ring po can sa sros nas shar ba mthong na yang zla tshes brjed* (supralinear note: 15) *'dug / rab nyi'i sa stag gi mjug gi hor zla gnyis pa'i smad la tho rangs shar du du ba chung ba can byung / de'i rgyun sa yos gsum pa'i yar ngos* (*sic.* read *ngo*) *tho rangs la pa wa sangs kyi byang*

It guided the development of Tibetan astronomy. Some answers are given in chapters 1 and 2. I believe that even if eclipses cannot explain all aspects of Tibetan astronomy, given their religious significance in Tibetan Buddhism, astronomical observations are to some degree linked to the increase in the accuracy of eclipse calculation. In the same vein, we could ask the following questions: Why does astronomical observation matter? What compelled Tibetan astronomers to observe the sky? What significance do observations have in Tibetan astronomy? In what aspects did they make a contribution? Another aspect of Tibetan astronomy in conjunction with observation is that it does not remain merely observation. Since Tibetan astronomers do not cast doubt upon the authority of the *Kālacakra*, observations which may contradict the *Kālacakra* were re-interpreted in order to reconcile them with the *Kālacakra.* The *Kālacakra*'s meager information on astronomy may evince limitations (from a modern perspective), but its essential and supreme status has never been questioned. In Tibetans' conception, the *Kālacakra* is the fount of all possible solutions and explications. It also means that no antithetical relation between canonical/religious knowledge and empirical/observational knowledge is posited in the Tibetan *skar rtsis* astronomy based upon the *Kālacakra.*

[266] The genre of *myong byang* (including the genre of *nyams yig* in medicine) is important in Tibetan intellectual history because it contains empirical and observational knowledge on the practices of astronomy and medicine. For example, Dharmaśrī (1999a: 149b ff.) contains the *myong byang*s and *man ngag*s passed down before and around Dharmaśrī for eclipse calculation. In it, we can read Dharmaśrī's criticism of the elipse calculation based upon his previous *myong byang*-s. Regardless of its apparent importance in Tibetan intellectual history, it is unfortunately difficult to pinpoint the writers and the texts that appear in it—mostly because it does not give full-scale information, and our modern accumulated knowledge on Tibetan *rtsis* research is too meager for us to speculate them. Most importantly, it seems that no texts remains among those it mentions.

[267] De Jong (1967: 208-16) is one of the earliest research efforts, but unfortunately, it does not mention the astronomical content.

ngos su rtse mo lho nub bstan pa chung ba mthong / yang de'i gsum pa'i nyer gsum nyer bzhi nas bzung ste bzhi pa'i bcu gcig bcu gnyis bar du srod la me bzhi'i mdun dbo'i thad du skar chen 'dra ba zhig las du ba rtse mo shar bstan dang / phyis su (supralinear note: *lnga par*) *skar chung 'dra ba du bas g.yogs pa lta bu las rtse mo cung zad thon pa byung /* (sublinear note: *bdun par* 28 *'od dmar byung*) *yang sa yos de'i zla ba bcu gcig pa'i bcu drug bcu bdun sogs nas srod la lho rgyal gyi rgyab ngos su rtse mo shar bstan zhig shar ba phyis su smin drug thad du sleb nas yal song / sa glang* (supralinear note: 1) *lo'i bdun pa'i nyer bzhi nyer lnga sogs nas tho rangs smig* (*sic. smin*) *drug gi rgyab tu rtse mo nub bltas du ba cung zad ring tsam shar te yal nas phyis su dgu pa bcu pa'i mtshams su sa sros la yang shar / de'i phyi lo lcag stag gi lnga pa'i yar tshes lnga drug nas sa sros la shar drang thad du chu stod kyi g.yas su skar chung 'dra ba du bas g.yogs pa nya zla 'dra ba zhag 'ga' la shar nas / bcu nas byang ngos sme bdun thad du song nas zhag 'ga' zhig nas yal ba / mthong / de nas bzung ste sa phag lo'di'i bar* (supralinear note: 10) *du 'dir ma mthong / 'on kyang gong smos de dag gi tshes grangs snga phyi cung zad re nor pa yod dam snyam lags /*[268]

I saw, a few times, *drang srong* (S. *ṛṣi*) *du ba can*. It was comparable to the statement that a long comet appeared in Mnga' ris in the iron-tiger year of the previous 11th *rab byung* (*rab drag*) (*lcags stag lo* / 1650 C.E. ~ 1651 C.E.); a very long comet that appeared in the dusk was observed also in Amdo in the water-pig year (*chu phag lo* / 1743 C.E. ~ 1744 C.E.) of the 12th *rab byung* (*rab nyi*), but I forgot the date (15). A small comet appeared in the east in the 2nd *hor zla,* the last *hor zla* of the earth-tiger year (T. *sa stag lo* (= 1699 C.E. in this case)) of the 12th *rab byung*. Continuously, a small comet whose small peak was shown in the southwest, was observed to the north of Venus at daybreak of the waxing phase of the 3rd *hor zla* of the earth-hare year (*sa yos lo* / 1699 C.E.). Also a comet with a peak appeared from something like a big star, facing the *uttaraphālgunī* in front of *hasta* at dusk from 23rd/24th of the 3rd *hor zla* of the year to 11th/12th of the 4th *hor zla*, and later (supralinear note: in the 5th *hor zla*) [the comet's] peak emerged a little from something like a small star, which is covered by the comet. (sublinear note: 28 red light emerged in the 7th *hor zla*). Also, there was one whose peak appeared in the dusk on the 16th/17th of the 11th *hor zla* in the earth-hare year (T. *sa yos lo* (= 1700 C.E. in this case) at the back of the sourthern continent faded away towards the *kṛttikā* later. A comet whose peak was towards the west at the back of the *kṛttikā* at daybreak appeared for some time and then disappeared on the 24th/25th of the 7th *hor zla* in the earth-ox year (*sa glang lo* / 1709 C.E. (supralinear note: 1)), and later appeared again at dusk on the border between 9th and 10th. One disappeared on the 10th towards the Big Dipper in the north and faded away some days after. Something like a small star covered by the comet, which is something like a full moon, appeared a few days directly on the right of the *pūrvāṣāḍhā* at dusk on the 5th/ 6th of the waxing moon of the 5th *hor zla* of the following year iron-tiger year (*lcag stag lo* / 1710 C.E.). Thereafter, it was not observed from that year to this year, earth-pig year (T. *sa phag* (1779 C.E. ~ 1780 C.E.) (supralinear note: 10)), However, I think that there may be a small error back and forth in the aforementioned dates.

[268] Sum pa Mkhan po (1979c: 13a-13b).

The above passage clearly demonstrates comet-observational data coming down to Sum pa Mkhan po, and observations made also by Sum pa Mkhan po himself.[269] My guess is that observations, records and relevant content that have been hitherto ignored may exist somewhere in Tibetan writings.

The example of an eclipse that I could identify is as follows: Phu klung Dge slong Blo bzang yon tan's (17th c.) *Nyi zla gza' 'dzin gyi ri mo myong byang* (1387 C.E. ~ 1687 C.E.) is mentioned by the Sde srid. "*phu klung par g.yu* (*sic.*) *lo*[270] *nas kyi rab bdun nas da lta'i bar gyi ri mo dang byung ba'i myong byang gi dpe 'dug par ... / .*"[271] The translation "[I (= the Sde srid) witnessed] Phu klung Dge slong Blo bzang yon tan has the figures and the experience notes (*myong byang gi dpe*) from the seventh *rab byung* (beginning from 1387) up to now (around 1685 in which the *Vaiḍūrya dkar po* was completed) given by G.yu lo pa." It is verified from the passage that the observations were made continuously over a long

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[269] For Sum pa Mkhan po's observations of *du ba mjug ring*, see also note 576. We should begin to accumulate data and knowledge that enable us to assess the role of observation in the development of Tibetan astronomy in general, and in eclipse calculation in particular.

[270] Dalai lama V conveys some information on this G.yu lo pa. See Dalai Lama V (2009: 22-4) and Dalai Lama V (2009a: 437): The lineage of the teaching heard is as follows: Dpal mgon 'phrin las pa - Phug pa Dpal seng pa (Dpal gyi seng ge) – Sngags 'chang G.yu lo pa (= Bla mkhyen G.yu lo pa) - Gnyag(s) ban Nang ra ba Bla mkhyen Ngag dbang 'jam dpal blo gros who is contemporary with Dalai lama V. Dpal mgon 'phrin las pa and Dpal gyi seng ge, who are important figures in the transmission of the *Phug* tradition, were active in the 16th century. See below note 285. And given the fact that Gnyag(s) ban is a contemporary of Dalai lama V, it is safely assumed that G.yu lo pa lived in the 16th or 17th century.

[271] Sde srid (1996: 68). The 7th *rab byung* (*rab bdun*) ranges from 1387 to 1446. Since Blo bzang yon tan is a contemporary of the Sde srid, it is not likely that he observed and calculated the eclipses before the 17th century. Because Blo bzang yon tan received the *myong byang* from G.yu lo pa, it is possible that the latter also received it from his predecessors. It records the observations made in the 14th century. Tshul khrims rgyal mtshan (1986: 362) and Tshul khrims chos 'byor et al. (1982: 29) also mentions the *myong byang* without textual evidence.

period of time, from 1387 to around 1685. In particular, the Blo bzang yon tan's two *myong byang*s [272] include his own calculation results together with observations. It is known from the notes in their *kha byang* (written by someone else. possibly by the Sde srid) that, rather than blind acceptance of observations made by Blo bzang yon tan and previous scholars and astronomers, a critical appraisal has been made of their observations and calculations. One of the *kha byang* of the two *myong byangs* reads as follows:

> *phu klung dge slong blo bzang yon tan gyi gza' 'dzin skor myong ba'i lab rigs /*
>
> "Humble view[273] of the section on the eclipse experienced by Phu klung Dge slong Blo bzang yon tan."

And right below it, there is the following note in red ink.

> *phu klung pa gza' 'dzin la brtson pa che ba nas chu phag lo dri* (*sic.* possibly *bris*) *ba byas pa la lar rgyud 'grel sogs yig cha dang ri mo rtsa ba ma phigs pa'i rtags mang bar mchan btab cing la lar yas mas 'gal rgyab lhur*[274] *myong byang la dgag pa kyang yod do /*

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[272] These texts contain Blo bzang yon tan's observations and calculations of the eclipses which occurred during the 11th *rab byung* (roughly 1630s-1680s). This means that Blo bzang yon tan lived in the 17th century. They merit detailed research. It would fill in the gap in Tibetan history of astronomical observations in the context of ancient astronomy. Together with them, there is another *myong byang* composed of 38 folios. The *kha byang* reads as follows: "A clear note [written] with vermillion red color on the eclipses which ocurred in the wood-mouse year (1684 C.E. ~ 1685 C.E.) in the 11th *rab byung* according to the treatise *Vaiḍūrya dkar po* and visual phenomena on the way back home." (*rab byung bcu gcig pa'i shing byi nas brtsams nyi zlar sgra gcan rim byung bstan bcos bai dkar nang bzhin dang / yul lam du mthong snang rnams mtshal skag sogs kyi mchan gsal bcas bkod pa*). In it, the observations of the eclipses during the 11th *rab byung* and the 12th *rab byung* are included together with *skar rtsis* calculations. All the three texts provide evidence that long-term observations of eclipses have been made, combined with criticism generated by real calculations of the values reflecting empirical corrections on time, node, etc.

[273] The "*lab*" means chat. It is a humble way of expressing his speech and writing. The "*rigs*" means thought", "thinking", "view". That is why the "*lab rigs*" is rendered as such by me.

[274] The "*rgyab lhur*" is a tentative reading. The *dbu med* letters are not clear at all. The "*rgyab*" may be "*rgyab 'gal*". It may be given in this text as "*'gal rgyab*". The "*lhur*" may mean "*lhur len*" / "*lhur blangs*". Since the two words are not clear, my rendering may be awkward.

"This note (T. *mchan*) has been made with many signs without understanding the fundamental values and the texts, such as *Kālacakra* commentary and others, in some calculations in the water-pig year (1683 C.E.) by Phu klung Dge slong Blo bzang yon tan with great devotion to eclipses. There exists denial of the experience note (*myong byang*) in which there are self-contradictory statements in some places above and below."

T*he kha byang* of another Blo bzang yon tan's 10-folio text reads as follows:

rab byung bcu gcig pa'i nang gi nyi zlar sgra gcan 'jug tshul ri mo dang rjes rtags kyi mthong myong bkod pa bzhugs / .

"Herein exists the writing of the values of the way of Rāhu's entering to the sun and moon and the experience [note or calculation][275] of the following sign (T. *rjes rtags*) within the 11th *Rab byung*."

The following note exists right below the *kha byang* in red ink.

phu klung dge slong blo bzang yon tan gyi myong byang ri mo sogs la 'di gar rtsis shes 'dra ri mor zhus bskyar byed bcug pa la rang gi'ang nges pa'i yid ches tsam dang la lar dogs gnas zhal lung gi thun mong ba skar mda' me mig tu bzung ba dang thig le bzhi lnga brtsegs pa sogs ri mo yig cha'i rtsa ba ma phigs pa'i rtags kyang mang yang gza' 'dzin rang la re mkhor (maybe *res 'khor*) *sā ra mngon /*

"[I (possibly the Sde srid)] let someone who seems to know calculations repeatedly edit the values in Phu klung Dge slong Blo bzang yon tan's *myong byang*, and [I] also have a confidence in understanding it with certainty. However, in some places, [I have two] doubts, i.e. that which [Blo bzang yon tan] apprehended the general method of the *Pad dkar zhal lung* as $5^{k}23^{q}$ (T. *skar mda' me mig*)[276] and piled four 0-s or five 0-s.[277] [As such,] there are many signs without [his] understanding the fundamentals of the text, ...[278]"

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[275] The *myong byang* is a note based upon experience and observation. The *myong rtsis* is a calculation based upon experience and observation. Both may be appropriate in this context.

[276] The "*zhal lung gi thun mong ba skar mda' me mig tu bzung ba*" is not understandable. My translation is tentative. More research into the *Pad dkar zhal lung* and the *myong byang* is needed.

[277] The "*thig le bzhi lnga brtsegs pa sogs*" is not understandable. More research is needed.

[278] The part "*yang gza' 'dzin rang la re mkhor sā ra mngon*" is not understandable. So, I could not translate it. The *sā ra* (= *rgya mtsho*) seems to designate the Sde srid Sangs rgya rgya mtsho. More research is needed to understand this part.

It is not certain who (possibly the Sde srid?) wrote the criticism down. As criticism is a major part of Tibetan intellectual history, so is it a major factor in the research into *rtsis*. Of course, the criticism does not go beyond the boundary of the *Kālacakra*. The foundation and reasoning of the criticism is and remains within the *Kālacakra*.

Tibetans' observations may not be restricted to eclipses, solsticial points, comets, etc. It is possible they recorded celestial phenomena observed via their naked eyes and instruments. It is speculated that besides the above examples, many examples await us in some unknown or known texts. If some data are accumulated, we could tackle the issue of how the observations have been reflected in real calculations through traditional and modern methods. Then, we could obtain a more detailed and broader perspective of Tibetan astronomy.

2.2. *MAN NGAG* (ORAL INSTRUCTION): THE TRANSMISSION OF EMPIRICAL KNOWLEDGE[279]

Information regarding eclipse calculation in the *Kālacakra* is limited. Tibetan astronomers compare observations with real calculations through which empirical knowledge has been accumulated. In real eclipse calculations, empirical corrections have been applied to the eclipse limit, timing correction, duration, magnititude, direction, color, etc., for which relevant information is not found in the *Kālacakra*. It may be assumed that the process has contributed to the accuracy of eclipse calculation with the formation of the unique Tibetan *skar rtsis* astronomy.

Here, I focus on the development of empirical knowledge for eclipse calculation, passed down to later generations in the form of *man ngag*. It was combined with the *guruśiṣya* (master-disciple. T. *bla ma brgyud pa*) relationship within a school or tradition. There is no remarkable difference among different schools and traditions in terms of the process of eclipse calculation. However, minor differences are seen, which are partly related to the fact that each tradition has combined individual observations and empirical data. As a matter of fact, no uniform numbers and quantities in terms of the eclipse limit, timing, duration, magnititude, direction, color, etc. are seen in Tibet—even

279 Empirical knowledge is the accumulated and non-theoretical knowledge formed by experience, observation, experiment, etc. Therefore, it is closely tied to 2.1. Nevertheless, the reason why I separate this part from 2.1 is that I focus on the media through with knowledge is transmitted: 2.1 is a record note (*myong byang*) combined with observation. 2.2. is oral instruction (*man ngag*) combined with sectarian transmission.

if all the methods in *skar rtsis* generally follow the same algorithm.[280] For example, 'Bri gung Dkon mchog 'phrin las bzang po's (1656-1718) *Byed grub thun mongs* (*sic.* read *thun mong*) *kyi rtsis kyi bstan bcos khol bur ston pa mkhas pa dgyes pa'i spyod yul*, written in 1678, seems to be a fundamental text for the development of the 'Bri gung tradition of eclipse calculation.[281] He conveys the empirical knowledge he inherited for the calculation of eclipses. The empirical data date back to Dus zhabs Shākya dbang phyug (active. 15th c.)[282] at the latest. I am not sure of the exact location where he mentions this in his text, but at least some explanation for the direction is Dus zhabs's knowledge transmitted by means of *man ngag*.[283] In later periods, the knowledge transmitted to and described by Dkon mchog 'phrin las bzang po keeps finding its way continuously into the 'Bri gung tradition. For example, an unknown author in the sect, which is based upon *byed rtsis* (this is an influence from the Sde srid), combines *man ngag* and *myong rtsis* that was transmitted to him. It gives more credence to Dharmaśrī's *Nyin byed snang ba* (1990) with a *grub rtsis*

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[280] For an understanding of the Tibetan algorithm of eclipse calculation, see Henning (2007: chapter 3).

[281] Dkon mchog 'phrin las bzang po (1975: 54a) was written during the day of the waxing moon on the fifth month of 1678 C.E. (= *dus kyi pho nya yi snron zla ba'i yar tshes*). He was the 24th abbot of 'Bri gung monastery (*'Bri gung che tshang* 02, 1656-1718). For him, see 'Bri gung Bstan 'dzin Pad ma'i rgyal mtshan (1770-1826) (1989: 289-303). For the Chinese translation, see Kezhu qunpei (1995: 226-36).

[282] He is known as a *kālacakra* scholar of the lineage of the *snye mo sku zhang*. For a brief overview of the lineage, see http://www.tbrc.org/#!rid=G4397: "This seat of the zhwa lu sku zhang of snye mo is meant a monastery of the Bu ston lugs of the *kālacakra* located in Phu gsum shang founded in the 11th century by Zhwa lu sku zhang Bkra shis rgyal mtshan."

[283] Dkon mchog 'phrin las bzang po (1975: especially, 51b).

stance in terms of the practice of *nur ster* (*nur byin*) [284]. As seen from this, Tibetans attempted to make sense of *rtsis* (calculations) on the basis of all the possible sources available.

Each sect, which quite possibly incorporated the observations and empirical data available in each region, continuously absorbed and embraced empirical results. The accumulated empirical knowledge has been transmitted as *man ngag* within each sect. In particular, before the methods in the Sde srid's *Vaiḍūrya dkar po,* Dharmaśrī's *Nyin byed snang ba* and *Gser gyi shing rta* took deep roots in Tibet, it is highly possible that each sect transmitted different values and methods reflecting regional differences, even if the method and procedure were already fixed. We need more knowledge regarding this; if data are accumulated, we may be able to clarify the meaning of the numbers by means of modern and traditional methods. It should be also noted that although the Sde srid's *Vaiḍūrya dkar po* and Dharmaśrī's *Nyin byed snang ba, Gser gyi shing rta* have taken deep

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[284] Anonymous1 (1985: 295). We can obtain a little information on this text in Anonymous1 (1985: 302): "Written by the one entitled *khri chen* as is spoken by Khri sprul rin po che Chung tshang." (*khri sprul rin po ches chung tshang gsung ltar / khri chen ming gis lags so /*). We do not know who the author is, but it is certain that he is a contemporary of Dharmaśrī at the earliest and possibly later than Dharmaśrī. He uses the *byed rtsis* method and is well aware of Dharmaśrī's *grub rtsis* method. Anonymous1 (1985: 301): "This is nothing but *byed rtsis*: if compatible with *grub rtsis*, *sgra gcan nur ster* $0^{k}31^{q}41'4''10(23)$ (i.e. correcting the longitude of *sgra gcan mjug* or *sgra gcan gdong* by subtracting the value $0^{k}31^{q}41'4''10$), and the *nur ster* of *chu tshod* (adding some *chu tshod*) to time, etc. the *Nyin byed sngag ba* is more profound." (*'di ni byed pa kho na ste / grub pa'i rtsis dang bstun pa na / sgra can* (*sic. gcan*) *nur te bya ba dang /* (0 31 41 4 10) *dus la chu tshod nur ster sogs / nyin byed snang ba zab par 'dug /*). And Anonymous1 (1985: 299-301): Solar eclipse condition adopts Phyag mdzod's value: sun – *sgra gcan gdong* < 50^{q}, *sgra gcan gdong* – sun < 5^{q}, sun – *sgra gcan* < 8^{q}, *sgra gcan 'jug* (*sic.* read *mjug*) – sun < 40^{q}. See Henning (2007: 129). There is an intriguing *man ngag* in it: Anonymous1 (1985: 301): "Furthermore, it is said that [when the sun] is close to Mercury and Venus, solar and lunar eclipses are difficult [to occur] and even if they occur, the size is small and the length is short." (*gzhan yang lhag pa pa sangs gnyis / nye ba nyi zla 'dzin dka' zhing / 'dzin kyang cha* (*sic.*) *chung yun thung gsung /*). Observations have been made continuously and the empirical knowledge and data accumulated have been transmitted by means of the succession of the *guruśiṣya*.

roots since they were publicized, the values and methods accumulated prior to them were not simply ignored. Rather, they remained as a possible explanation. This may cause a hermeneutical issue, which will be mentioned below. No definite answer or solution is given in the text.

Thus, we may read the traces of the different numbers and quantities and methods in later *rtsis* texts. That could mean that later texts may be the confluence of the earlier and lingering traditions, which show evidence of the indigeneous sectarian methods. Again, we need more research into the transmission of astronomical data in individual sects. Through experiences (*myong rtsis*) and observations, which have been transmitted in the form of *man ngag* and possibly with sectarian differences, Tibetans have filled a gap of knowledge which does not exist in the *Kālacakra*. Experiences and observations have been regarded as sources of reliable knowledge in the case of *rtsis*.

In another example showing that the accumulated empirical knowledge has been transmitted in the form of *man ngag,* or a certain method of transmission, Ku sri skyabs—who appears to belong to Chos kyi dbang phyug's tradition in the west (Brag dkar rta so in the region of Mang yul)—introduces empirical knowledge transmitted from such *Phug* scholars as Mkhas dbang 'Chi med bde ba[285] and Mang thos Shākya rgyal mtshan,[286]

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[285] 'Chi med bde ba (16th c.) appears *passim* in the Sde srid's *G.ya' sel.* For example, see the Sde srid (2002: Vol. 1, 162): "the existence of the *'Od zer brgya pa* of Dus rams pa 'Chi med bde ba." (*dus rams pa 'chi med bde ba'i 'od zer brgya par yod pa*). The Sde srid (2002: Vol. 1, 279) indicates that he is one of the disciples of the well-known *Phug pa* scholar Dpal mgon 'phrin las pa (15th c.-16th c.): "Dus rams pa 'Chi med bde ba heard *skar rtsis* and *nag rtsis* well from Dpal mgon 'phrin las pa." (*... dpal mgon 'phrin las par dus rams pa 'chi med bde bas legs par rtsis dkar nag gsan*). Ngag dbang (2002: Vol. 2, 341) [= the Sde srid (2002: Vol. 2, 341)]: "From the key teaching of the *'Od zer brgya pa,* a commentary on Dbyangs 'char, which is an extremely profound tradition transmitted from only Dus rams pa 'Chi med bde ba." (*... dus rams pa 'chi med bde ba nas brgyud pa'i ches zab pa chig brgyud ma'i dbyangs 'char gyi 'grel ba 'od zer brgya pa'i bka' gnad las ...*). The "*chig brgyud ma*" means a

tradition that was transmitted to just one person (in this case, ’Chi med bde ba). Ngag dbang (2002: Vol. 2, 398) [= the Sde srid (2002: Vol. 2, 398)]: “because Dus rams pa ’Chi med bde ba cut the extreme [of doubt] in *Dbyangs ’char,* etc. and a direct disciple of *Phug pa...* ” (*... dus rams pa ’chi med bde ba ’di nyid dbyangs ’char sogs la shin tu mtha’ chod cing phug pa’i dngos slob yin pas / ...*). Modern research into the history of the *Phug* tradition between the 15th century and the 17th century may help us to understand him. Tshul khrims chos ’byor (1982: 28-9), Tshul khrims chos ’byor and Bsod nams phun tshogs (1983: 55-9), Tshul khrims rgyal mtshan (1986: 360-2) can be summarized as follows: Dpal mgon ’phrin las pa composed many texts such as *Zhal lung mdzes rgyan*, *Lo zla’i ’go ’dzin*, etc.. His son was dull, and Dpal gyi seng ge, who carries the lineage of brother (*mched kyi rigs ’khyar* (*sic. ’khyer*)) — this means Dpal gyi seng ge is one of the family members — was taken as the lineage of the *Phug* system. Rab ’byams pa Pad ma chos skyong appeared, and thoroughly completed the entire *skar rtsis* and *nag rtsis.* The lineages of *Phug pa* were broken off from Dpal gyi seng ge, but Dus rams pa ’Chi med bde ba heared *skar rtsis* and *nag rtsis* from Dpal mgon ’phrin las pa. He became an expert the in *Dbyangs ’char.* In 1624, Dpal ’byor ’phrin las rab rgyas composed *Rtsis skar nag gi dri ba.* After that, *Phug pa* lineage holders such as Zur chen Gzhon nu don grub (? -?), father of Smin gling Zur chen Chos dbyings rang grol (1604-1669) and Ldum po (bu) Don grub dbang rgyal (active in the 17th c.) from Lho kha Gra nang and Lu ’go Bla mkhyen Ngag dbang appeared. For Ngag dbang, see below note 422. Going back to ’Chi med bde ba, he was a student of Phug pa Dpal mgon ’phrin las pa and is a *Dbyangs ’char* (*Svarodaya*) specialist. As for ’Chi med bde ba’s works, ’Chi med (1980) seems to be his text. The colophon in ’Chi med (1980: 117-8) indicates that “I, lustrous ’Chi med ... ” (*dpal ldan ’chi med bdag ...*) wrote ’Chi med (1980) by compiling (T. *gcig tu sdebs pa*) the writings of *Svarodayatantra,* Glo bo Lo tsā ba Shes rab rin chen (13th c.), Lo chen Nam mkha’ bzang po (14th c.), Gsal grags (?), the Bo dong tradition, G.yul rgyal ba Ston pa Blo gros’s (?) practice manuals (T. *lag len*), many *paṇḍita*s from India, Jumlā in Karnālī, Nepal, etc.. This text looks to be one of the important *Svarodayatantra* texts that shows the transmission and dissemination of the theory and practice of *Svarodayatantra* in early Tibet. The other texts included in *Rare Tibetan Astrological Texts from the Kyirong Lama Kunsang Collection* (1980) are not ’Chi med (or possibly ’Chi med bde ba’s) texts. The volume also consists of many short pieces collected in a disorderly manner. Hitherto-unknown astronomers are identified in it: Me ṭi hrā dza (= Mai ṭi hrā dza < S. *Maitrīhṛdaya. Or, if *hrā dza* derives from S. *rājā*, it may be Maitrīrājā), Rdo rje, etc. Concretly, the *kha byang* in the piece ranging from page 419 to page 425 reads as follows: “Herein exists the eclipse [calculation] of the *grub rtsis*. [It is] the oral instruction of astronomer/ astologer Mai ṭi hrā dza. *Maṃgalam*.” (*grub rtsis kyi nyi zla gza’ ’dzin bzhugs so / rtsis rig smra ba mai ṭi hrā dza’i man ngag go / mangalam /*). The *kha byang* in the piece ranging from page 426 to page 438 reads as follows: “[This] appeared from *Sgra can ’od zer* which has six means of the particular oral instruction of eclipses.” (*gza’ ’dzin gyi man ngag khyad par ba’i chos drug dang ldan pa sgra can ’od zer las byung ba’o /*). Pages 436-7 indicate that an astronomer named Rdo rje wrote it in the fire-ox year (T. *me glang*. The *rab byung* is unknown) in Phu lag rdzong shol (zhol ?). Other pieces by this man are also seen: the *kha byang* in the piece ranging from page 123 to page 160 reads as follows: “There are diagrams of the lustrous *Svarodaya Yuddhajaya* (victor in battle). [It is] the simile of great bliss of jewels. - I am not sure how to translate the compound *nor bu bde ba chen po* in connection with *’dra dpe. - maṃgalam*.” (*dpal dbyangs ’char ba g.yul las rnam par rgyal ba’i dpe’u ris yod / nor bu bde ba chen po’i ’dra dpe’o / mangalam /*). And page 159 indicates that Mang thos Rdo rje wrote it (pp. 123-160) in the *nag zla* (3rd month in the *Kālacakra* system used later) of the water-monkey year (T. *chu spre*. The *rab byung* is unknown) in ’Phu lag rdzong zhol. And the *kha byang* in the piece ranging from page 175 to 227 reads as follows: “Herein exists the *Byed grub rtsis kyi bsal* (*sic.* read *gsal*) *byed zla ba’i ’od zer*, the subsequent garland of the *Pad dkar zhal lung* written by Dus ’khor ba Rdo rje. *maṃgalam*.” (*byed grub rtsis kyi bsal* (*gsal*) *byed zla ba’i ’od zer zhes bya ba / zhal lung gi rjes ’phreng / dus ’khor ba rdo rje’i* (*sic.* read *rdo rjes*) *mdzad pa bzhugs / mangalam /*). Page 226 indicates that Rdo rje wrote it at Phu lag rdzong zhol in the *nag zla* of the year of fire-female-ox (T. *me mo glang*. The *rab byung* is unknown). TBRC indicates that the *Byed grub rtsis kyi gsal byed nyi ma’i ’od zer zhes bya ba pad dkar zhal lung gi bzhed gzhung* (Rewalsar: Zigar Drukpa Kargyud Institute, 1985), is another work by Mang thos Rdo rje, but I had no chance to read personally.

being mostly based upon the Sde srid's *byed rtsis* for eclipse calculation.[287] Since I have not found the methods used by the two elsewhere, this is a valuable source to show both their methods and how previous methods were incorporated into the later text without simply being dismissed.

> *gzhan yang mkhas dbang 'chi med bde ba dang / mang thos shākya rgyal mtshan rim rgyud* (*sic.* read *brgyud) pa'i / zhed* (*sic.* read *bzhed*) *srol byed sgrub tshes 'khyud zla skar dang / sgra gcan gdong 'jug* (*sic.* read *mjug*) *gang nye'i* (*sic.* read *nyes*) *mang la nyung / sbyangs lhag byed par skar thig (0) dbyug gu la / nga gnyis (52) tshun la 'dzin par 'gyur pa dang / sgrub par byang lhag bco lnga (15) tshun la 'dzin / byed par 'dzin shar sgrub par ma shar na / sgrub pa'i tshes 'khyud dbyug gur mkha' me (30) byin / drug cus (60) phud pa'i*[288] *skar byin de dang sbyang / sbyangs lhag zhe drug (46) tshun la 'dzin pa 'gyur / grub par chu tshod bar khyad ma byin par / 'grig na byed pa'i tshad las che bar sgrib / grub par 'dzin shar byed par ma shar na / de na bsdus rgyud rtso* (*sic.* read *gtso*) *bas 'dzin mi 'gyur / tshad ni sbyangs lhag chu tshod dbang pos (5) bgos / thob nor thig le nas ni rig byed par (0 1 2 3 4) / byung na zla ba ril 'dzin bgos lhag mar / cig gnyis sum lus tha* (*sic.* read *mtha'*) *nas cung zad lus / mda' nas phyogs gyi bar (5 6 7 8 9 10) byung drug cha re / mi sgrib pa ni rig* (*sic.* read *rigs*) *pas rtag par bya / drug cha sgribs kyang 'dir ni mi mngon gsung /*[289]
>
> Furthermore, in case that the remainder of the difference [between] *tshes 'khyud zla skar* of the *byed rtsis* and *grub rtsis* [in accordance with] the tradition of the linear transmission of

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[286] If Ku sri skyabs belongs to Chos kyi dbang phyug's tradition, it leaves room for questions regarding how the knowledge of 'Chi med bde ba and Shākya rgyal mtshan survived in the West. In fact, we have no knowledge about the author. Once he is identified, we will be able to go further. Ku sri skyabs (1979) conveys much information and simultaneously asks many questions in terms of the transmission of astronomical knowledge after the Sde srid. It is surely an important text in *rtsis* studies.

[287] Ku sri skyabs follows the Sde srid's eclipse calculation method based upon the *byed rtsis*. For example, Ku sri skyabs (1979: 36b-37a)'s judgement of the possibility of eclipse is based upon the Sde srid's *byed rtsis* method. He presents the distance between Rāhu and the moon (*sgra gcan zla ba'i bar khyad*): the moon – *gdong* < 57, *gdong* – the moon < 50, *dus me* (= *sgra gcan mjug*) – the moon < 50, the moon – *dus me* < 45. The conditions are the same with the Sde srid's value. See Henning (2007: 104-5). For the Sde srid's defense of *byed rtsis* for eclipse calculation because of empirical reason, see the Sde srid (1996: 69). The Sde srid defends *byed rtsis*, but he does not present an explanation of why *byed rtsis* is right or should be used. For more information on the Sde srid's menthod for eclipse calculation, see Henning (2007: chapter 3).

[288] *phud* = *khyer* = divide.

[289] Ku sri skyabs (1979: 47a-47b).

Mkhas dbang 'Chi med bde ba and Mang thos Shākya rgyal mtshan and Rāhu's head or tail whatever [the value] is close [to the *tshes 'khyud zla skar*], which subtracts the smaller one from the bigger one [among the two values] is 0 *skar gnas* / 52 *ghaṭikā* (or *daṇḍa*) below, there will be a [lunar] eclipse in *byed rtsis* and if the difference is 0/15 below, there will be a [lunar] eclipse in *grub rtsis*. If there is an eclipse in *byed rtsis*, but there is not in *grub rtsis*, then 30 are added to the *tshes 'khyud zla skar* of the *grub rtsis* and [the result] is subtracted from the value where the quotient after being divided by 60 is added to the *skar gnas*. If the difference is 46 below, there will be an eclipse. If eclipse value agrees without adding the difference of *chu tshod* in the *grub rtsis*, [ ] is obscured being bigger than *byed rtsis*. If there is an eclipse in the *grub rtsis*, but there is not in the *byed rtsis*, then, there will not be an eclipse, due to being mainly based upon the *Bsdus rgyud* (S. *Laghukālacakra*). As for the size, divide the *chu tshod* of the difference [between *tshes 'khyud zla skar* and the Rāhu value] by 5. In the case that the quotient is 0 ~ 4, [there will be] a total lunar eclipse. [However,] in the case that the remainder after the division is 1 ~ 3, light will remain a little at the rim (= not completely obscured). In the case of the quotient 5 ~ 10, $\frac{1}{6}$ each[290], but there no obscuration, this should be investigated by reasoning. Lunar eclipse is not seen here even if $\frac{1}{6}$ is obscured. [The information] was stated by [Mkhas dbang 'Chi med bde ba and Mang thos Shākya rgyal mtshan].

Whether all the values and methods in the above passage were given by 'Chi med bde ba and Shākya rgyal mtshan are not clear. Actually, Ku sri skyabs relies more on *byed rtsis* than on *grub rtsis* regarding the judgement of eclipse possibility. It may be the influence of the Sde srid. Or, 'Chi med bde ba and Shākya rgyal mtshan may have also based more upon *byed rtsis*.

Next, let us think about how Ku sri skyabs deals with the conflicts, contradictions and uncertainty that may occur in the transmission and expansion of knowledge by means of *man ngag*, emergence of advanced texts, mutual interactions, etc.

gnyis pa nyi 'dzin ri mo cung khag kyang / ... che chung sbyang lhag ... shākya rgyal mtshan lugs / sbyangs lhag mes (3) bsgyur dus (6) bgos thob nor la / gzugs (1) shar drug cha me shar sum cha dang / mda' (5) shar sum gnyis ri (7) shar ril bor sgrib / bcu bdun (17) phyed sgrib nyer gnyis (22) sum cha sgrib / gsung kyang mkhas pa'i gsung rnams cha sdur rtsi / sgrub par sbyang lhag bcu (10) tshun 'dzin pa dang / lhag na mi 'dzin byed par 'dzin pa shar / sgrub par ma shar nyi dag chu tshod

[290] He means the following: 5: $\frac{5}{6}$, 6: $\frac{4}{6}$, 7: $\frac{3}{6}$, 8: $\frac{2}{6}$, 9: $\frac{1}{6}$, 10: $\frac{0}{6}$ obscured each.

du / mkha' me (*30*) *sbyin la drug cur long na sgrib / de dang sgra gcan gang nye sbyang lhag du / bzhi bcu* (*40*) *tshun shar 'dzin cing grub rtsis su / bar khyad ma snan (sic.) 'dzin shar sgrub pa rtso* (*sic. gtso ?*) */ dus ni byed pa'i tshes long gdong 'dzin phyogs (10) / 'jug* (*sic.*) *'dzin ma nu* (*14*) *snan* (*sic.*) *pa rdzogs khar sgrib / grub pa'i tshes long rdzogs khar sgrib pa yin / ... ces 'bai dkar dgong don las byung ba'i rtsis zhi* (*sic. gzhi*) *rin chen 'phreng ba las zla nyir sgra gcan gyis sgrib tshul gyis* (*sic.* read *gyi*) *ri mo mngon med bstan chos (sic. bstan bcos) 'bai* (*sic. bai*) *dkar dgongs don sor zhag (sic.* read *bzhag) thog mkhas dbang lhun grub rgya mtsho 'chi med bde ba mang thos shākya rgyal mtshan sogs kyi* (*sic.* read *kyis*) *mdzad pa'i myong rtsis phran bu dang bcas bkod pa'i le'u ste bdun pa'o /*[291]

Secondly, solar eclipse values are a little difficult, but ... size, the difference (T. *sbyang lhag*. remainder after subtraction) ... the tradition of Shākya rgyal mtshan says that the quotient obtained from multiplying the difference by 3 and dividing by 6: 1 rises: $\frac{1}{6}$, 3 arises: $\frac{1}{3}$, 5 arises: $\frac{2}{3}$, 7 arises : total eclipse, 17: $\frac{1}{2}$, 22: $\frac{1}{3}$ obscured, but [ ] compare the statements of other learned scholars and calculate. If the difference is 10 below in *grub rtis*, there is an eclipse; if [the difference] is 10 above, there is no eclipse, but there is an eclipse in *byed rtsis* [in the latter case]. In the case of no eclipse in the *grub rtis*, if [the result] reaches 60 [by] adding 30 to the *chu tshod* of the value of *nyi dag*, there is an eclipse. If the difference between the result and Rāhu, whatever is close, is 40 below, there is an eclipse, and if an eclipse occurs without adding the difference in *grub rtsis*, [ ] take the *grub rtsis* as a basis. Timing is as follows: in the *byed rtsis*, [the sun is] obscured at that point of the completion, i.e. [at the time of] adding 10 to the *tshes long* of the *byed rtsis* in the case of *gdong 'dzin* (eclipse by *sgra gcan gdong*), and [at the time of] adding 14 to the *tshes long* in the case of *'jug 'dzin* (eclipse by *sgra gcan mjug*). In *grub rtsis*, [the sun is] obscured [at the time of] the *tshes long* at the point of the completion ... This is chapter seven of the *Rtsis zhi* (*sic. gzhi*) *rin chen 'phreng ba,* which derives from the intended meaning of the *Vaiḍūrya dkar po,* that wrote the values of the way of the moon and sun's being obscured by Rāhu, including *myong rtsis phran bu* written by Mkhas dbang Grwa phug pa, 'Chi med bde ba, Mang thos Shākya rgyal mtshan, etc. on top of leaving the intended meaning (T. *dgongs don*) of the uncertain (T. *mngon med*) treatise *Vaiḍūrya dkar po* untouched.

This passage begins with the famous phrase seen in the explanation of solar eclipses in Tibetan *rtsis* texts, i.e. "solar eclipse calculation is difficult." It is mostly based upon *myong rtsis* of Grwa phug pa, 'Chi med bde ba, and Shākya rgyal mtshan each of who seems to have written *Myong rtsis phran bu.*[292] This may mean that *man ngag* is not the medium of

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[291] Ku sri skyabs (1979: 48a-49b).

[292] It is difficult to pinpoint which solar eclipses each scholar witnessed. It would be a huge and difficult project to investigate all solar eclipses during their lifetimes. Modern technology may give some answers for the venue and time where the solar eclipses were observed and some rationale for why the values were given as such.

the transmission of their knowledge based upon observations. From the above passage, it is not difficult to imagine that eclipses were observed, recorded, compared and contrasted with real calculations, and that some empirical values were formed during the period the *Phug* scholars. Of course, it would be better to say that such observations, calculations and recordings must have occurred from the beginning of the Tibetan *skar rtsis* or earlier. Unfortunately, not many materials have been found yet. I hope more materials emerge. Ku sri skyabs (1979) is a rare instance that manifests the eclipse calculation method by early *Phug* scholars.

Going back to my topic, I focus on hermeneutical issues that can be approached from the following two issues: conflict and uncertainty. In the first case, Ku sri skyabs attempts to make sense of the longitudinal difference between *grub rtsis* and *byed rtsis*, which caused serious problems in Tibetan eclipse calculations. He also asks other scholars to compare and contrast multiple sources with criticism regarding the emergence of no correspondence between *rtsis* and eclipse phenomena. However, even if a system is contradictory to real phenomena, he does not repudiate it. It remains as a possible method and keeps being compared and contrasted with other methods. This is because many parts of Tibetan eclipse calculations are justified by empirical knowledge. It may be that it aims at "saving the phenomena" in a situation where theoretical approaches are inherently limited—since the *Kālacakra* corpus, the only locus through which Tibetans could learn astronomcial theory, does not work.

For the second case, Ku sri skyabs is based upon Buddhist hermeneutics. In the above passage, he mentions "intended meaning (*dgongs don*) of the uncertain (*mngon med*) treatise *Vaiḍūrya dkar po*." Regarding the solar eclipse calculation, he says:

> *'khrul med bsdus rgyud dgongs don gtso /... mkhas dbang mi rje sangs rgyas rgya mtsho'i bka' rtsom 'bai dkar dgongs don 'khrul med yin / .* [293]
>
> [take] the unmistaken *bsdus rgyud* as a main intended meaning (T. *dgongs don*). ... The intended meaning (T. *dgongs don*) of the *Vaiḍūrya dkar po,* the writing of the Sde srid, king of learned ones, lord of men, is unmistaken.

The "unclear" part in the Sde srid is *dgongs don*. In other words, it was intended by the Sde srid. Moreover, in the following, the *dgongs don* is applied very vaguely and comprehensively in terms of solar eclipse condition, size, time, etc.:

> *padma dkar po'i zhal lung phugs* (*sic.*) *lugs thams cad mi mda'* (*sic.* read *gda'*) *ba'i dgongs pa'i don / gsal por ston pa'i 'jam dbyangs mi'i rje sa ri'i bka' rtsoms mngon med bai dkar ma bu'i dgongs don chu thigs tsam zhig ri mo'i lam nas phyin phyi* (*sic.* read *ci*) *ma log par mkhas dbang brgyud pa'i phyag rgyun ltar lhur blangs nas / ... .*[294]
>
> ... having made efforts regarding the intended meaning (T. *dgongs don*) of the uncertain (T. *mngon med*) compositions, *Vaiḍūrya dkar po*, the mother-text, and the son-text (T. *ma bu*)[295] of Mañjuśrīghoṣa lord of men Sa ri (= the Sde srid) which clearly show the non-existent intended meaning (T. *dgongs pa'i don / dgongs don*) of all *Phug* traditions [including/ represented by] the *Pad dkar zhal lung*, by means of the values of a mere drop of water, unmistakenly according to the lineage of the learned scholars ...

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[293] Ku sri skyabs (1979: 44a-47a).

[294] Ku sri skyabs (1979: 72b).

[295] The *ma* is the *Vaiḍūrya dkar po*; the *bu* is Nor bzang rgya mtsho's texts.

According to Ku sri skyabs, the unclear part in the *Pad dkar zhal lung* is elucidated by the Sde srid's *Vaiḍūrya dkar po.* This means that the former has *dgongs pa.* Ku sri skyabs himself explained the unclear part in the Sde srid's *Vaiḍūrya dkar po* by referring to different traditions that preceded him; they possibly include writings and *man ngag* in his traditions. Therefore, the Sde srid's text is regarded as *dgongs pa can* (= require further explanations). Ku sri skyabs strikes a compromise between his research and the Sde srid by assuming that his writing is exactly what the latter intends (T. *sor bzhag.* "put as it is").[296] We do not know how he can make this assumption.

The hermeneutical tool *dgongs pa* is not merely related to the justification of experiences and observations as noted above, but also may be related to making sense of astronomy in general. For example, if the *Kālacakra* is "not clear but unmistaken", then it needs further explanations (= *dgongs pa can*). From a different perspective, it may be said that the abstraction and esoterism in the *Kālacakra* leads to *skar rtsis,* which may be regarded as that which elucidates the "unclear" points according to the "unmistaken" *Kālacakra*, being based upon concrete observations, experiences, empirical knowledge, even different traditions, etc.

[296] For the division between *neyartha* and *nītārtha* in Buddhist hermeneutics and the four criteria for *neyartha* in the Tibetan hermeneutics, *dgongs pa* (S. *abhiprāya*), *dgongs gzhi*, *dgos pa* (S. *prayojana*), and *dngos la gnod byed* (S. *mukhyārthabādha*), see Seyfort Ruegg (1985: 309): "*dgongs pa* "intention, intended meaning, purport" and *dgongs pa can* "pertaining to intention, intentional," said of a *sūtra* text the surface meaning of which does not reflect the ultimate and definitive intention of the Buddha." See also Seyfort Ruegg (1988: 1-4), and Lopez (1988: 55-6).

Does this make sense? We might conjure up a simple response: The reason why *dgongs don* is raised in Tibetan astronomy is that information in the *Kālacakra* or *skar rtsis* texts is lacking or is wrong/different. In other words, the information in it is not "unclear and unmistaken." Moreover, the hermeneutic strategy may raise some obscure points: It seems difficult to demarcate between 1) and 2). The "uncertain" includes "wrong?" By which criteria is a certain opinion or argument embraced or rejected? Considering the conflicting situation among knowledge sources, can the term *dgongs pa* be used? And can the *dgongs pa* be applied to the interpretation of the texts/methods which had existed even before certain knowledge was formed? Can this situation be regarded as "uncertain"? It may be intriguing to answer these questions by using astronomical texts based upon Buddhist hermeneutics. However, the final and ultimate answer looks to be fixed as far as my observations are concerned. In other words, it is a paradox.

At some point, some observations, data, arguments, etc., may appear contradictory or "uncertain", but will be compromised and interpreted under the bigger scheme of the *Kālacakra*. The seemingly conflicting different knowledge sources including experience, text, canon, etc., will be applied in individual cases without being discarded, thereby strengthening the extant system. Every single source for eclipse calculation is partly true and partly wrong if not written in the *Kālacakra*. There must not exist contesting sources in the Tibetan conception.

In Tibet, transmitted knowledge was not simply discarded by later scholars. Rather, making sense of and reconciling it with various later sources were made not only in eclipse calculations but also in astronomy in general. In the course of doing so, Buddhist hermeneutics based upon the concept of *dgongs pa* became a solution when scholars were confronted by “unclear” points.

The *man ngag* is inherently combined with observations, empirical analyses, and so on, some of which has been identified in *rtsis* texts. It is also assumed to have interacted with the textual traditions, and it comprises a significant part of the transmission of astronomical knowledge. Inevitably, it is involved in the Buddhist hermeneutics, about which we may find more textual evidence in the future. In fact, Buddhist hermeneutics may penetrate every single aspect of the interpretation of religio-astronomical phenomena. In other words, we may be able to find more evidence regarding how it has been applied also in *myong byang*, *dris lan*, *skar rtsis* commentaries, and even *rgya rtsis* exegeses.

2.3. *DRIS LAN* (LETTERS): CRITICISM, DEBATES AND DISCUSSION AMONG SCHOLARS

One of the non-textual knowledge sources consists of interactions among intellectuals. Many topics related to observations, empirical data, discussion on astronomical texts, different opinions and traditions that either strengthen or decline astronomcial ideas were discussed and debated. Examples are found in such texts as *chos ’byung*, *rtsis*, *dris lan*, etc.

In this work, I attempted to present some astronomical ideas seen in letters. Repeated interactions among scholars facilitated sharing and exchange of information as well as criticism. Many productive and fruitful words and ideas must have disappeared, but the genre of *dris lan* fortunately offers a wide range of topics and issues such as theories, calculations, religious/ philosophical viewpoints, different traditions, etc., regarding astronomy. Scholastic concerns not seen in treatises or commentaries are described vividly and concretely in this genre. It has contributed to strengthening the *skar rtsis* / *Kālacakra* system.

For example, the letters that contain astronomical contents include Byang bdag versus Mkhas grub,[297] Dharmaśrī's letter to the Sde srid in the *Dri lan skor rmongs pa'i mun sel legs bshad nyi ma'i snying po las skar nag rtsis kyi dri lan skor phyogs bsdus.*[298] Ngag dbang to the Sde srid is included in the Sde srid's *G.ya' sel.*[299] Sum pa Mkhan po versus the Paṇ chen lama is included in Sum pa Mkhan po (1979c).[300] Sum pa Mkhan po versus Ngag dbang nyi ma is included in Sum pa Mkhan po (1979c). Aside from these, there must be many *dris lan* that mark important moments of Tibetan history of astronomy. So far they have ignored by modern scholars, and they await research.

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[297] For the texts in which the letters are included, see below note 590.

[298] See van der Kuijp (2012: 2).

[299] About Ngag dbang, see Schuh (1973a: 39-40), van der Kuijp (2012: 2), see below note 422.

[300] Sum pa Mkhan po discussed many topics, including astronomy, with the Paṇ chen lama in the second Tibetan month of 1780 (T. *lcags byi*) at Sku 'bum; see Dkon mchog 'Jigs med dbang po (1728-1791) (2002: 822). For the Chinese translation, see Bsod nams tshe ring (1990: 414). Also, for nearly the same account, see Brag dgon Zhabs drung (1987: 63). For its Chinese translation, see Wu Jun et al. (1989: 68).

It is certain that *dris lan* offer a wealth of information on astronomy, but reading *dris lan* has its limits. Some letters were replied to, but some were not. Also, some replies may have disappeared. Moreover, answers may deviate from the original questions partly because they are not given during face-to-face discussion or debate. Most of all, it is difficult to concentrate on solving a certain topic or issue consistently. It is highly possible to end as a letter of Einmaligkeit.

There may exist more methods and approaches for the accuracy of eclipse calculations in *skar rtsis*, but the above three appear typically. Next, we will look into the Tibetan response to Chinese astronomical systems, which may be one of the most salient features in the 18th century.

2.4. THE *MĀ YANG RGYA RTSIS*: RESEARCH INTO DIFFERENT TRADITIONS

The Tibetan astronomy has absorbed neighboring traditions on the basis of the Indic *Kālacakra* tradition since the beginning. One of the most important external traditions in the 18th century is Qing Chinese astronomy.[301] In this section, I focus on how

[301] The *Kālacakra* is regarded as the text of the last phase of Indian esoteric buddhism. It means that after the transmission of the text into Tibet, the transmission of astronomical knowledge from Indian Buddhism lessened. Of course, some techniques from the west seems to have been transmitted sporadically. For example, Phyag mdzod conveys a tradition from Nepal named *kar myang gi rtsis*. It is a tradition related to precipitation. Its epoch is 78 C.E. We have no idea when it was introduced. For more information, see Huang and Chen (1987: 232). In later periods, especially after the 17th century, interests in Chinese astronomy/ astrology/ almanac were active. Because my research focuses on the 18th century, I have no choice but to tackle the Qing Chinese astronomy/astrology introduced to Tibet. It should be noted that later periods are not the only periods where we can witness Tibetan attention to Chinese astronomy. On the contrary, it was

the Tibetan *skar rtsis* astronomy absorbed the different traditions and methods in eclipse calculations. In that respect, the first *Mā yang rgya rtsis* text, the *Rgya rtsis snying bsdus*, reproduced in Huang and Chen (1987a) and the *Rgya rtsis chen mo* (see the section of political concern following this section) are important. — the *Rgya rtsis chen mo* predates *Rgya rtsis snying bsdus*. But the former has no real significance for the history of Tibetan astronomy. — In this chapter, I will introduce the historical background of these two texts and the mathematical and calculational background in the fourth and last chapter.

THE TRADITION OF THE *MĀ YANG RGYA RTSIS*[302]

ubiquitous since the Tibetan Empire. Such records are easily found in some texts. If we find textual evidence in *Chos 'byung* text, for example, Bsod nams rgyal mtshan (1993: 74) writes the following during the time of Thon mi sambho ṭa (7th c.): *shar gya dang / mi nyag gi yul nas bzo dang rtsis kyi dpe blangs /*. For the English translation, see Sørensen (1986: 180). A similar account is found in Dpa' bo (2006: 100) for the same period: "[ ] received books of technology and astrology from China and Mi nyag (possibly Tangut) in the east". (*shar phyogs rgya dang mi nyag nas / bzo dang rtsis kyi dpe rnams blangs /*). And except for the *Kālacakra*, Tibetans have never conducted full-scale research into different astronomical systems. Later period *Mā yang rgya rtsis* is also just the introduction of eclipse calculation algorithm included in the *Lixang kaocheng*. In other words, under the situation that the *Kālacakra* astronomy and cosmology is dominant, only the adoption of eclipse calculation methods was made.

302 It is known that the tradition in Amdo began from Mā yang Bzod pa rgyal mtshan. Texts belonging to this tradition are not plentiful. The Bla brang bkra shis 'khyil Catalogue edited by Grags pa (1985: 42-7) lists several important texts such as Drung yig (2006), Dpa' ris Sngo kho tshang's *Bsam 'phel dbang gi rgyal po*, etc. The text title indicates that of Ser chen Zhabs drung (1861). I have no idea of the relationship between the two. Future researchers may have gain access to 'Jam dbyangs bzhad pa's library at Bla brang bkra shis 'khyil in which the texts in the *Catalogue* are stored. Dme shul Chos 'phel's *Pad dkar chun po rgyas pa,* — See Schuh (1973: 309) : No. 324/ Hs. sim. or. JS 626. *Mā ha cina'i rtsis la nye bar mkho ba dbugs sgang gi ri mo bsgrub tshul dang tshes grangs kyi re'u mig nam mkha' mig dbang lag pa'i grangs su spel ba padma dkar po'i chun po bcas* (Epoch: 1900). — *Pad dkar chun po bsdus pa, Brtag thabs shes rab ral gri* and its *re'u mig.* Recently, Ahua Awanghuadan (2013: 324) confirms that Guojia tushuguan in Beijing has 'Ul gyi ba thu's (possibly < M. Ölǰeibatu) *Ma hā ci na'i lugs kyi nyi zla gza' 'dzin gyi ri mo 'bri tshul* 34 folios. See also Huang (2002: 216). Bzod pa rgyal mtshan, the founder of the so-called *Mā yang rgya rtsis* in Amdo, is difficult to identify, but the date and area of the aforementioned astronomers are mostly identified. Except for 'Ul gyi ba thu, who was active in Beijing in the late 19th century, they appeared in Amdo after the 19th century. Among them, Ser chen Zhabs drung and Drung yig are earlier *Mā yang rgya rtsis* writers. Ser chen Zhabs drung's writings give some information on the dissemination of the tradition in Amdo. For example, Ser chen Zhabs drung (1861: 20b), which is a nearly unreadable *dbu med* writing: "May the practice of *rgya rtsis* be clarified like daytime by this

one that Khri rin po che Sngo kho Spyan snga Ngag dbang legs bshad nyi ma at Mchod rten thang bkra shis dar rgyas gling gave big presents such as silk scarf, three *sku*-s (statues), and … , received the insistent speech [made by him] that there is a need to compose a complete and elaborate *rgya rtsis* section, with great reverence, and Ser chen sprul sku named Ki rti shā sa na rda ra (< S. Kīrtiśāsanadhara > T. Grags pa bstan 'dzin) wrote at the age of 43, at the time of the completion of the 15th day of the third month (*nag zla*) in the 14th *rab byung* iron-chicken year (1861 C.E.) at Zhwa dmar bkra shis chos gling dgon!" (*… mchod rten thang bkra shis dar rgyas gling gi khri rin po che sngo kho spyan snga nas ngag dbang legs bshad nyi mas lha dar sku gsum dang / dam chos x* (illegible) *ljid mo sogs gsol ras rgya chen po gnang ste 'di skor cha tshang rgyas pa zhig brtsams dgos zhes bka' nan chen po gnang ba spyi bos blangs te / zhwa dmar bkra shis chos gling dgon gyi ser chen sprul ming ba ki rti shā sa na rda ras rang lo zhe gsum pa rab yid lcags bya'i lo nag pa zla ba'i tshes bco lnga'i nyin rdzogs par sug bris bgyis pa 'dis kyang rgya rtsis kyi lag len nyin mo ltar gsar bar gyur cig /*). For research into Sngo kho Ngag dbang legs bshad nyi ma (19th c.) him, see http://www.tbrc.org/#!rid=P368 : He is a teacher of Brag dgon Zhabs drung. For Mchod rten thang bkra shis dar rgyas gling (Ch. Tiantangsi (天堂寺)), see Pu (1990: 554-6), Smith1 (2013: 299, 435): it is located at Dpa' ris (Ch. Tianzhu 天祝). The colophon of Ser chen Zhabs drung's other writing (n.d.: 20a), which is the appendix to Ser chen Zhabs drung (1861): "The appendix for establishing *bskal li*." (*bskal li bsgrub tshul zur du bkod pa /*). Ser chen Zhabs drung (n.d.: 21a): "in the *sa ga* month of the water-dog year in the 14th *rab byung* (1862 C.E.) in the method/ tradition of …". (*… lugs su rab yid chu khyi'i lo sa ga'i zla la … .*). This part is mostly illegible. And Ser chen Zhabs drung (n.d.: 20a-20b): "After Mkhas dbang Drung yig Thub bstan rgya mtsho at Bla brang bkra shis 'khyil heard that there are a few *rgya rtsis* sections which accord with the current *hwang li* (< Ch. *huangli* 皇歷 / *huangli* 黃歷), the letter sent out requesting to send whatever *rgya rtsis* sections exist to me, together with a silk scarf, arrived, but … Sngo kho Sprul sku Rin po che (I have no idea who this is) says "please compose an entire section of this!" to me, [gave] gifts of white silk scarves and [I] kept the words, with a golden head ornament, in mind (= never forgot the words) changelessly, and Drung yig Thub bstan rgya mtsho also via letter *gza' skar*, *nyi khams* (Ch. *ganzhi* 干支), intercalation method, big and small month (30 day month/ 29 day month in the Chinese lunar calendar), *dus gzer* (Ch. *jieqi* 節氣), eclipse, *sa glang*, etc., … ." (*kho bos da lta'i hwang li dang mthun pa'i rgya rtsis skor re gnyis bgyis yod pa bkra shis 'khyil gyi mkhas dbang drung yig thub bstan rgya mtshos gsan nas / bdag la rgya rtsis skor gang yod bskur dgos tshul gyi yi ge lha rdzas rten bcas gnang ba lag tu 'byor yang / … sngo kho sprul sku rin po ches bdag la 'di skor cha tshang zhig rtsoms shig ces lha dar dkar ba'i x* (illegible) *legs skyes dang / bka' lung 'gyur med gser gyi cod paṇ gtsug tu bcings pa dang / drung yig thub bstan rgya mtshos slar yang yi ge'i lam nas nyin re'i gza' skar / nyi khams / bshol dang / zla ba che chung / dus gzer / gza' 'dzin / sa glang sogs x* (unclear) *ci rigs las brtsams pa dang /… .*). The condition of the *dbu med* of Ser chen Zhabs drung (n.d.) is poor. The typed Tibetan of the colophon has been also given in Huang (1987: 242). For *sa glang*, see Henning (2007: 176-80). Taken together, Ser chen Zhabs drung is a *sprul sku* at Zhwa dmar bkra shis chos gling dgon (> Ch. Xiamasi 夏玛寺). — For the monastery, see Wang Qian and Dan qu (2000: 177): it was founded in the 17th century and is located in present-day Dpa' ris. For its location, see Smith1 (2013: 300, 436). — And he is a contemporary of Drung yig and Brag dgon Zhabs drung Dkon mchog bstan pa rab rgyas. Drung yig is verified to be a secretary at Bla brang bkra shis 'khyil. A little more information on him is confirmed in Brag dgon Zhabs drung (1987a: 93a) [= Brag dgon Zhabs drung (2006: 1367)] whose original epoch is 1867. The original print is not available to me. In the case of both (1987a) and (2006), the *rtsis 'go* has been changed into 1987/3/0 by the lamas who are responsible for the creation of an annual almanac in the Dus 'khor grwa tshang at Bla brang bkra shis 'khyil (T. *dus 'khor grwa tshang gi rī thu 'gan 'khur ba rnams)* and was carved by the lamas named Blo bzang sbyin pa and Bstan pa at Bla brang bkra shis 'khyil (They possibly also belong to the Dus 'khor grwa tshang). Brag dgon Zhabs drung (1987a: 92b-93a) [= (2006: 1367)]: "Drung yig Thub bstan rgya mtsho placed the summary of the necessary section as it is in the form of appendix as the great throneholder (T. *khri chen)* Vajradhara Dbal mang Paṇḍita Dkon mchog rgyal mtshan was diligent in the way correct values must exist in the *rgya rtsis* section. Drung yig Thub bstan rgya mtsho, who has knowledge of the five sciences, and his disciple Rgyal mtshan bstan pa did multiplication and division of (= calculated) the values and editing, etc. … ." (*rgya rtsis skor kyi ri mo rnam dag zhig dgos tshul khri chen rdo*

The *Rgya rtsis snying bsdus* is divided into three sections: calculation of true conjunctions (T. *dag pa'i nya* / *dag pa'i tshes*), method of calculating a lunar eclipse, and method of calculating a solar eclipse.[303] Let us first discuss the authorship together with its origin and provenance. Its authorship is problematic.[304] After investigating some *Mā yang rgya*

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rje 'chang / dkon mchog rgyal mtshan pas nan tan mdzad pa bzhin drung yig thub bstan gyis nyer mkho'i skor bsdus pa zur rgyan gyi tshul du rang sor bzhag / snga (*sic.* read *lnga*) *rig smra ba drung yig thub bstan rgya mtsho nyid dang / nye gnas rgyal mtshan bstan pa gnyis kyis ri mo'i bsgyur bgod dang gang ci'i zhu dag sogs grogs ldan gang dgos bgyis te / ... .*). A statement made by Dbal mang Paṇḍita Dkon mchog rgyal mtshan and heard by Brag dgon Zhabs drung is included in Brag dgon Zhabs drung (2001: 430): "[I (= Dbal mang Paṇḍita) will tell] my secretary Thub bstan rgya mtsho to write the original manuscript of my biography. ... when I (= Dbal mang Paṇḍita) obtain *dbyangs 'char*, and especially the reliable and accurate *rgya rtsis* in Beijing, etc. the way of delivering [it = *rgya rtsis*] to this monastery (= Bla brang bkra shis 'khyil) ... ." (*rje de'i drung yig thub bstan rgya mtsho la rnam thar sa bon 'bri rgyu / ... dbyangs 'char dang khyab* (*sic.* read *khyad*) *par rgya rtsis khungs ldan zhib cha can re pe cing sogs nas rnyed tshe dgon pa 'dir 'phrod thabs / ... .*). Taken together, Drung yig is a secretary of Dbal mang Paṇḍita Dkon mchog rgyal mtshan (1764-1853) at the monastery of Bla brang bkra shis 'khyil. By the above passages related to the two relatively earlier *Mā yang rgya rtsis* writers in Amdo, i.e. Ser chen Zhabs drung and Drung yig, I estimate that the *Mā yang rgya rtsis* tradition did not fully blossom even in the 19th century. Rather, the tradition looks to be in the beginning phase, as evidenced by the curiosity about and interests in the tradition from contemporaries of the two writers.

303 For a understanding of this tradition, see the excellent research of Huang and Chen (1987a). Since the original manuscript of the *Rgya rtsis snying bsdus* reproduced by it is not available, I follow the computerized text and the numbering in Huang and Chen (1987a).

304 Huang and Chen (1987a) insists that Mā yang Bzod pa rgyal mtshan, who was active around 1744 (the epoch of the *Rgya rtsis snying bsdus*), is the founder. However, there are several issues to think about regarding this claim: First, the manuscript of the text has not yet been published yet. Huang and Sun (2012: 216) presents the three manuscripts of the text: 1) The first manuscript is composed of 16 folio. Its epoch is 1744. Where it has been stored is not indicated. The computer input is found in Huang and Chen (1987a). 2) It is a 27 folio manuscript. Its epoch is 1842. Where it has been stored is also not indicated. 3) The epoch has been changed into 1876 by Blo bzang 'od zer (?-?). It is a 12 folio xylograph (C.P.N. Catalogue, nos. 01414-19, 01483-4.). According to Huang and Sun (2012: 215-6), the second text states: "The one written by Mā yang Bzod pa rgyal mtshan." (*ma yang bzod pa rgyal mtshan gyis sbyar ba*). Then, we have a problem: Does it mean that the epoch was changed from the first one written by the same author? Or, was Mā yang Bzod pa rgyal mtshan active in the 19th century? Secondly, Huang and Chen (1987a) does not present the 18th century calculational tables. Because most of the *Mā yang rgya rtsis* text indicate how to use calculational tables, the text is useless without the tables. Huang and Chen (1987a) presents Dme shul Chos 'phel's (late 19th ~ early 20th c.) tables. Thirdly, there is the issue of identifying the alleged founder Bzod pa rgyal mtshan. It is worth mentioning van der Kuijp's research into the colophon of the *Mā yang sman yig gces btus* and an account of the Dalai Lama VI (1988). See van der Kuijp (2015: 460-1). For information about the Tī thung Rdo rje 'chang, see Pu (1990: 560-2), and Smith1 (2013: 299, 437). However, it is probable that the colophon in which Mā yang Bzod pa rgyal mtshan appears was attached later. The printing blocks were carved during the period

rtsis texts, written after the *Rgya rtsis snying bsdus*, my findings on the tradition are as follows: the *Rgya rtsis snying bsdus* was written by a lama in Beijing in the 18th century. Then Mā yang Bzod pa rgyal mtshan encountered the text and first dissmeminated the method in Amdo.[305] Let me present my evidence. Mi pham (2012a),[306] written in 1912, explains the differences between many astronomical traditions with a focus on later-period eclipse calculations. In it, Mi pham also conveys some information on *Mā yang rgya rtsis*.

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of Gubci elgiyengge Xianfeng (咸豐; r. 1851-1861) Emperor. Another factor pertaining to the identification of Mā yang Bzod pa rgyal mtshan presented by van der Kuijp (2015: 460) is Brag dgon Zhabs drung (1987: 575-6) [= Chinese translation, Wu Jun et al. (1989: 542)]: *Mā yang rtsis pa*, a *Mā yang rgya rtsis* astronomer who taught 'Jam dpal bstan pa'i sgron me (1802-?) who was born in the water-dog year (1802) appears in Brag dgon Zhabs drung's *Mdo smad chos 'byung* (written in 1865). Given this information, it is certain that *Mā yang rgya rtsis* was being taught in Mā yang dgon after 1802 in the early 19th century. For the introduction of Mā yang dgon, which was established in the ninth year of Abkai wehiyehe Gnam skyong Qianlong (1744 C.E.), see Brag dgon Zhabs drung (1987: 111-2). For the Chinese translation, see Wu Jun et al. (1989: 111). Huang and Chen (1984) shows that it was founded in 1740 on the basis of Dalai Lama VI and Ngag dbang lhun grub dar rgyas (1981: 143). For the Chinese translation, see Zhuang (1981: 101). Also see Pu (1990: 63): "Mā yang dgon Bkra shis chos gling (Ch. Mayingsi 馬營寺): located in Mayinggou (馬營溝) in Dpa' ris and is a sub-temple of Dgon lung byams pa gling (Ch. Youningsi 佑寧寺)." Also see Smith1 (2013: 286, 435). All in all, through the points mentioned in this note in terms of manuscripts, the calculational tables, and the identification of Bzod pa rgyal mtshan, it is doubtful that he created the text in the 18th century. As will be clarified below, I think he is the founder of the *Mā yang rgya rtsis* tradition in Amdo in the early 19th century, and the actual founder of the tradition may be a Beijing lama who lived in the 18th century.

[305] Ser chen Zhabs drung claims in his text, written in 1861, that Bzod pa rgyal mtshan is a key figure in the dissemination of the tradition. Ser chen Zhabs drung (1861: 20a): "Mā yang Bzod pa rgyal mtshan extensively spread the calculation method of this tradition in this region ... " (*phyogs 'dir mā yang bzod pa rgyal mtshan gyis / lugs 'di'i brtsi srol rgya chen phye zin ...*). He is the founder of the tradition in Amdo.

[306] Mi pham is well aware of the *Mā yang rgya rtsis*. In fact, it was pointed out by Henning's (2007: 99) loose translation: "In his *Great Commentary* on the *Kālacakra Tantra*, "The Illumination of the Vajra Sun," Mipham's frustration at the state of Tibetan eclipse prediction is made clear... discusses the need to take into consideration geographical location when examining solar eclipses. He makes the point that Chinese methods are often superior to those in use in Tibet ... ." For Tibetan, see Mi pham (2012: 1030-1). Mi pham's level of understanding of the *Mā yang rgya rtsis* is well displayed in Mi pham (2012a).

> *rgya rtsis mchod pa'i me thog punḍa ri ka'i phreng mdzes zer ba / rab byung bcu bzhi pa'i shing byi nas lo mgo bzung ba / nyer mkho'i zur 'debs bung ba bzi ba'i ca co rtsis* (*sic.*) *bkra shis 'khyil ba zhig gis brtsams pa yod /... rab yid shing byi sogs 'das lo'i nyi mas bsgyur / rgyal zla sogs 'das zla bsres / ... dpal ri ba'i* (*sic.*) *ma yang dgon gyi rtsis rig pa bzod pa rgyal mtshan gyis gsungs so /*[307]
>
> There is a text called *Rgya rtsis mchod pa'i me thog punḍa ri ka'i phreng mdzes* written by a person at Bla brang bkra shis 'khyil [= Drung yig Thub bstan rgya mtsho], whose epoch is the wood-mouse year (1864 C.E.)[308] of the 14th *rab byung* and whose indispensible appendix is the *Bung ba bzi ba'i ca co*. ... multiply 12 to the elapsed years counted from the wood-mouse year (1864 C.E.) of the 14th *rab byung*, add the elapsed months (T. *'das zla*) from the month of *rgyal.*[309] ... said Bzod pa rgyal mtshan, astronomer at the monastery of Mā yang in Dpa' ris.

As seen above, the tradition in Amdo dates back to Bzod pa rgyal mtshan. Mi pham introduces Mdzod ban Bstan pa rgyal mtshan's (birth: 19th century) *Rtsis kyi man ngag dpag bsam yongs 'du'i snye ma* as witnessed by him.

> *rtsis kyi man ngag dpag bsam yongs 'du'i snye ma zhes pa /*[310] *... rab yid mdzes byed chu yos la lo 'go bzung ba 'dug / .*[311]

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[307] Mi pham (2012a: 278-82).

[308] Chinese calendrical calculations begin from the year of mouse (Ch. *zi* 子. *jiazi*). The exact epoch date is 1863/12/0 (*grub rtsis*). 12/0 according to *grub rtsis* is the epoch in the *Mā yang rgya rtsis* tradition. For the explanation, see below note 682.

[309] The *'das zla* is also calculated from 12/0. The *Mā yang rgya rtsis* calculates *zla dag* according to *skar rtsis*. See below p. 313.

[310] Mi pham (2012a: 262-77) introduces this text written by Mdzod ban Bstan pa rgyal mtshan (birth: 19th century) in 1859 in Bla brang dbang ldan phyug mo (possibly Bla brang bkra shis 'khyil ?) and Mi pham (2012a: 277) indicates his other name was Dbyangs can dga' ba'i lang tsho. *Zhongguo shaoshuminzu guji zongmu tiyao, Zangzu juan, Xining fenjuan* (2010: vol. 3, 1142-50, especially 1150) indicates that a three-volume *gsung 'bum* of Tsha bo Bstan pa rgyal mtshan (= Mdzod ban Bstan pa rgyal mtshan) is extant in Sku 'bum. It also indicates that *Rtsis kyi man ngag dpag bsam yongs 'du'i snye ma* is included in volume *ga*.

[311] Mi pham (2012a: 262-3).

> I (= Mi pham) witnessed that there is *Rtsis kyi man ngag dpag bsam yongs 'du'i snye ma*, whose epoch is the water-hare year (T. *mdzes byed* / S. *śobhana.* the 37th year. 1843 C.E.) in the 14th *rab byung*.

Mi pham explains that in it, the tradition of the *Mā yang rgya rtsis* was mentioned in the following way:

> *... rig pa'i dbang phyug kun dga' chos dbyings rgya mtsho yi / rgyud dang 'grel las dngos shugs kyis / legs bstan rtsis kyi bstan bcos der / ... khyad par gong ma'i them mi mda'* (*sic.* read *'da*) *ba'i rgya rtsis de / drang srong mngon shes can zhig gis 'phro bzhag zer ba / rtsis 'phro dngos rnyed pa yin nam / dus 'khor rgyud ltar nyi longs shin tu dag snyam pa dang / nyi ldog gza' 'dzin sogs gang yang / 'khrul bral yin zhes kho bo'i* (*sic.* read *kho bos*) *zla ba dkar (sic.) nag rtsis rig la 'khrul pa'i dri med bzod pa rgyal mtshan pa las zhal gdams yang yang thos zhes 'dug / .*[312]
>
> In the astronomical treatise (= *Rtsis kyi man ngag dpag bsam yongs 'du'i snye ma*) well said directly and indirectly by the transmission and the commentary of the lord of knowledge, Kun dga' Chos dbyings rgya mtsho (?-?) ... especially, the *rgya rtsis* which cannot cross the doorway (= should be at the place where it is), and it is said that a sage (T. *drang srong* / S. *ṛṣi*) with higher perceptions placed the *rtsis 'phro* values,[313] there are [Mdzod ban's] passages [which was witnessed by Mi pham. Mi pham read the manuscript]: "I (= Mdzod ban) think that [its] *rtsis 'phro* was actually calculated or the longitude of the sun is extremely accurate as in the *Kālacakra*." "Solstices, eclipse, etc, whatever, are also unmistaken." "I (= Mdzod ban) repeatedly heard from Bzod pa rgyal mtshan, the immaculate one in the astronomy of *skar rtsis* / *nag rtsis*."

Mdzod ban mentions that a sage with higer perceptions (T. *drang srong mngon shes can*) is the original author. We do not know who he is. Moreover, Bzod pa rgyal mtshan is the transmitter of the tradition founded by the sage. It should be stressed that Mdzod ban, who was active (born (?)) in the 19th century,[314] is a contemporary of Bzod pa rgyal

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312 Mi pham (2012a: 267-8).

313 This is to adjust the Chinese *yingshu* (應數 = equivalent to Tibetan *rtsis 'phro*) values to the *rtsis 'phro* values in the *skar rtsis* system. For the information, see chapter 4.

314 Mdzod ban was was active in the middle 19th century. See above note 310.

mtshan, according to the above passage. The relationship between the sage and Bzod pa rgyal mtshan is not mentioned, but I speculate that the above passage alludes to the fact that there is a remarkable time difference between the two. It is odd that Bzod pa rgyal mtshan would not know the name of the sage if he had learned from him personally. At any rate, Mi pham does not identify the origin of the *Mā yang rgya rtsis* or who Bzod pa rgyal mtshan is. We have limited materials available for identifying Bzod pa rgyal mtshan. Nevertheless, the above quotation is powerful evidence that Bzod pa rgyal mtshan was active in the 19th century. Another compelling piece of evidence is a calendar (T. *lo tho*) reported by Huang at Bla brang bkra shis 'khyil. The colophon says: "In the Doro Eldengge Daoguang (Ch. 道光) 8th year (1828 C.E. r. 1821-1850) of the 14th *rab byung*, Mā yang Bzod pa rgyal mtshan and Ser chen Zhabs drung (possibly Ser chen Zhabs drung Grags pa bstan 'dzin) changed the *rtsis 'phro* from the previous one." (*rdo bkwang brgyad pa rab yid la mā yang bzod pa rgyal mtshan dang / ser chen zhabs drung rnam gnyis sogs kyis sngar las rtsis 'phro spo ba mdzad / .*[315]). In other words, the change of epoch was made in the early 19th century and Mā yang Bzod pa rgyal mtshan lived in the same century.

The colophon of the *Rgya rtsis snying bsdus* clearly states that Bzod pa rgyal mtshan learned the *rgya rtsis* method via oral transmission and created his own interpretation[316],

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[315] See Huang (1987: 235). Nevertheless, Huang (1987) maintains the claim that the *Mā yang rgya rtsis* tradition began from Bzod pa rgyal mtshan who lived around 1744 (= the epoch of the *Rgya rtsis snying bsdus*). At this point, let me use Huang and Sun (2002: 216) again: the second text's epoch has been changed to 1842. The text may be also the work of Bzod pa rgyal mtshan, who participated in the creation of the above almanac in 1828. Of course, at present, it is difficult to comment further because the original manuscript of the second text has not been publicized yet.

[316] Huang and Chen (1987a: 377). See also van der Kuijp (2015: 461-2).

but another colophon attached in the *Rgya rtsis snying bsdus*[317] states that a Beijing *rtsis rams pa* is the founder of the tradition.[318] What relationship exists between the *rtsis rams pa* and Bzod pa rgyal mtshan? What role does Bzod pa rgyal mtshan play in the transmission of the *Mā yang rgya rtsis*? It may be a pivotal question to resolve the issue of authorship. In this case, the 20th-century astronomer Smad Sog[319] Badzra's (d. 1918) testimony may be helpful.

> *gong ma bde skyid rgyal po yis / sngar gyi rtsis gzhung mtha' dag la / bcos bsgyur rtogs sla go bde'i phyir / rgya rtsis snying po phyogs sdebs te / shog grangs brgyad brgya lhag bcas spel / nyid kyi bka' bzhin rgya sog dang / bod kyi yi ge bcos bsgyur te / rgyal khams kun la dar rgyas mdzad / ... de nyid (chen lung) khri lo dgu pa'i tshe / sngar gyi rgya rtsis chen mo'i gzhung / mkhas pas* (*sic.* read *pa*) *pe cing rtsis rams pas / rab nyi shing byi rtsis mgo bzung / dus 'khor skar rtsis dang bstun par / bri bsrub* (*sic. bsgrub*) *ri mo'i* (*sic.* read *mos*) *gtan la phab / rgya rtsis snying po bsdus par grags / ... to bkwang brgyad pa rab yid la / mā yang bzod pa rgyal mtshan dang / se* (*sic.* read *ser*) *chen zhabs drung rnam gnyis sogs / sngar las rtsis mgo gsar bskrun mdzad /*[320]
>
> Elhe taifin Kangxi Emperor compiled the essence of Chinese astronomy in order to correct, transform, recognize, and to easily understand all the previous astronomical texts, and disseminated the text with more than 800 folios. Following his words, it was translated into Chinese, Mongolian (= *Tngri-yin udq-a*) and Tibetan (= *Rgya rtsis chen mo*), and it spread in the entire empire. In Abkai wehiyehe Qianlong Emperor's reign 9th year (= 1744 C.E.), a

[317] See van der Kuijp (2015: 462).

[318] The *Rgya rtsis snying bsdus* itself says that it was created in Beijing. See Huang and Chen (1987a: 367, 377): read [104], [105], and [196]. Then, there are at least two possibilities: A Tibetan in Beijing wrote it or Bzod pa rgyal mtshan visited Beijing in the 18th century. According to the above colophon, I side with the first possibility. See also van der Kuijp (2015: 462): "Its attribution to Bzod pa rgyal mtshan may be mistaken after all!" I do not agree with Huang and Chen (1987a), which says that the tradition was founded by Mā yang Bzod pa rgyal mtshan. He is the founder of the tradition in Amdo!

[319] The *smad sog* means inner Mongolia. Badzra derives from Sanskrit *vajra*.

[320] This part was written by Badzra in Drung yig (2003a: 417-8) [= appendix to Drung yig (2003)]. It does not exist in its original text, Drung yig (2006a) [= appendix to Drung yig (2006)].

learned Beijing astronomer took the wood-mouse year (= 1744 C.E.) of the 12th *rab byung* as the epoch for the previous *Rgya rtsis chen mo*, and determined the values in a way of being compatible with *Kālacakra*-based *skar rtsis*. [It] was known as *the Summary of the Essence of Rgya rtsis* (T. *Rgya rtsis snying po bsdus pa / Rgya rtsis snying bsdus* = Huang and Chen (1987a)). ... Doro Eldengge Daoguang 8th year (1828 C.E.) in the 14th *rab byung*, Mā yang Bzod pa rgyal mtshan and Ser chen Zhabs drung changed the epoch from the previous one (= the above whose epoch is 1744 C.E. = the *Rgya rtsis snying bsdus*).[321]

I surmise that his opinion may be based upon a general conception or belief among Tibetans, possibly transmitted orally: He says that a Beijing lama created the *Rgya rtsis snying bsdus* from the *Rgya rtsis chen mo*. I think he is partly right but also partly wrong—the lama created it, but from the *Lixiang kaocheng*, not from the *Rgya rtsis chen mo*. No continuation from the *Rgya rtsis chen mo* is posited.[322]

Taken together, I suggest that the tradition later known as *Mā yang rgya rtsis* was created in Beijing in the 18th century (around the epoch 1744 of the first work, the *Rgya rtsis snying bsdus*) and was not transmitted into the Amdo area until the early 19th century (perhaps it was the late 18th century; I have no evidence to refute this possibility given the evidence presented. However, it does not date back to the middle 18th century). I think Bzod pa rgyal mtshan must have visited Beijing or contacted someone who knows the Chinese method very well. Without sufficient knowledge or background, the Chinese method may seem arcane and esoteric. In any case, there is a possibility that he probably added his colophon in the *Rgya rtsis snying bsdus* without changing the epoch 1744. Since I

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[321] See above p. 150. This must be the same almanac Huang (1987) mentioned. Badzra also must have seen the text in Bla brang bkra shis 'khyil. The epoch is 1828 = earth-mouse (T. *sa byi*) year.

[322] For more information, see Chapter 4.

have not seen the manuscript of the *Rgya rtsis snying bsdus*, I am not sure about this. However, it may have happened in Tibet.[323]

Some may raise more possibilities regarding the authorship of the *Rgya rtsis snying bsdus*. It could be surmised that Bzod pa rgyal mtshan, who was possibly active during the 13th *rab byung* (1747-1806) [i.e. in the late 18th or early 19th century], may have visited Beijing and created the *Mā yang rgya rtsis* with epoch 1744 (Ch. *jiazi*, the first year of the Chinese calendar) in order to adjust the epoch values of the 13th *rab byung* (1747-1806).[324] Then, the created calendar is useful and effective during the 13th *rab byung*. This then is also a possible scenario, but we cannot explain the existence of the Beijing lama/*drang srong mngon shes can*. Some may say that Bzod pa rgyal mtshan could have created the text in the 19th century, for example in the 1820s, in order to adjust the Chinese epoch data to his own new system. He might have then changed epoch again to 1828 as specified in Huang (1987) and Badzra (2003a). This may be also possible because the latter calendar

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[323] For example, the reason why Schuh (1973) and Henning (2007) did not identify the original author of the *Rigs ldan snying thig* is that Mkhyen rab nor bu does not convey any information on Phyag mdzod in Phyag mdzod (1976). Even if its author looks like Mkhyen rab nor bu, it is actually not. In other words, it is possible that Bzod pa rgyal mtshan copied the original text and wrote his name down or forgot to cite the original author (or, did not know the name of the original author).

[324] Mkhyen rab nor bu (1943: 19a): "Because the palace established a law, Chinese masters (= astronomers) strictly kept everything secret, but being based upon various means of faith and action, the translations evolved gradually in the Amdo area from the 13th *rab byung* (1747-1806 C.E.)." (*rgyal khab kyis khrims su bcas pas rgya'i slob dpon nas bka' rgya dam bsgrags shin tu che yang / rab 'dod nang tsam nas dad sbyor gyi thabs sna tshogs la brten a mdo khul du rim bzhin 'gyur 'dug pa ... /* .). Mkhyen rab nor bu does not say that Bzod pa rgyal mtshan is the author, but the *Mā yang rgya rtsis* text came into being in Amdo during the 13th *rab byung*. I should point out two things: It may be a commonly believed idea among Tibetans. And Mkhyen rab nor bu, who mostly functioned in the 20th century, is the first one who introduces the *Mā yang rgya rtsis* method to Lhasa. His understanding of the history of the *Mā yang rgya rtsis* may not be reliable.

(epoch 1828) is effective in the 19th century, when Bzod pa rgyal mtshan may have lived. But, in this case, we have no choice but to admit that Bzod pa rgyal mtshan is the first author of the tradition. There is no room for the Beijing lama/*drang srong mngon shes can* in this case, too. I prefer the first opinion, given my textual research. As our research progresses, we may be able to find more evidence to come to a final conclusion.

THE *RGYA RTSIS SNYING BSDUS* AND THE CHINESE ORIGINAL TEXT *LIXIANG KAOCHENG*

Given the epoch, it is highly possible that the *Mā yang rgya rtsis* is related to the two Chinese astronomical systems, the *Lixiang kaocheng* and the *Lixiang kaocheng houbian*.[325] It is not likely that the earlier *Chongzhen lishu* or *Xiyang xinfa suanshu* was a consideration.[326] Let me investigate whether or not this predisposition can be justified.

[325] Here, I briefly give a context of the two. Firstly, the *Lixiang kaocheng* is the astronomical system adopted in Qing China after the *Xiyang xinfa lishu*. Since its epoch is 1684 (the year of *jiazhi* 甲子), it is called *Jiazhiyuan* (= *Kangxi jiaziyuan* 康熙 甲子元). It was used from 1726 (Hūwaliyasun tob Yongzheng (雍正) 4th year) to 1741. It is composed of three parts: 1) *shangbian* (上編) 16 chapters – *lili* (歷理 calendrical theory), 2) *xiabian* (下編) 10 chapters – *lifa* (歷法 calendrical methods), 3) *biao* (表 tables) 16 chapters. Putting aside complex and difficult theories and calculations in the astronomical system, I point out the following: the system features the Sinocization of western Jesuit astronomy. Roughly speaking, the *Chongzhenlishu* and the *Xiyang xinfa lishu*, which predate it, were compiled by Jesuits in Beijing. But, when compiling the *Lixiang kaocheng*, Chinese astronomers had some confidence in the principles and methods of the western Tychonic (Ch. Digu 第谷 < Tycho Brahe) astronomy, which enabled them to combine their traditional concepts and methods with Western astronomy. For this information, see Hashimoto (1970: 49-92, especially, 68). I mention it because it may mean that, as Chinese astronomers in Beijing began to makes sense of the western astronomical methods within their framework of Chinese astronomy, the western methods became more accessible to general Chinese astronomers—and even to Tibetan/Mongolian lamas in Beijing. This situation may have caused the genesis of the tradition later known as the *Mā yang rgya rtsis* in Amdo. In fact, the *Mā yang rgya rtsis* is totally based upon Chinese understanding of Western astronomical methods and mathematics, and Tychonic astronomy on which it is based is not explicit, as will be clarified below. Tibetans had no sense of what differentiates Tychonic astronomy from the other Western astronomies. The

Mā yang rgya rtsis is a mere Tibetan translation of the algorithm part of eclipse calculation in the *Lixiang kaocheng.* For the information, see below note 654. In other words, it is surely based upon Tychonic values and models, but it merely introduces the eclipse calculation skills understood and created by Chinese astronomers. Ultimately, it has nothing to do with the Tychonic astronomical theory. Going back to the *Lixiang kaocheng*, it revealed limitations in the solar eclipse prediction of 1730/8/1 [according to Qing Chinese lunar calendar]. As a result, Ignatius Kögler (1680-1746) and André Pereira (1690-1743) were ordered to revise the *Lixiang kaocheng*, and the revision, i.e. the *Lixiang kaocheng houbian*, was completed in 1742. Its epoch is 1723 (*guimao* 癸卯 year). So, it is called *Guimaoyuan* (= *Yongzheng guimaoyuan* 雍正癸卯元). It was used from Abkai wehiyehe Qianlong 7th year (1742) up until the end of the Manchu dynasty. For general research on the *Lixiang kaocheng houbian* with a focus on the difference from the *Lixiang kaocheng*, see Hashimoto (1971: 245-72), Shi (1993a: 959-63), Shi (2008): Kepler's elliptical orbit was applied to the calculations of the sun's motion (*richan* 日躔) and the moon's motion (*yueli* 月離). Improvements from the *Lixiang kaocheng* include the introduction of the new values of *taiyang dibanjingcha* (Ch. 太陽地半徑差, or diurnal parallax of the sun, difference of diameter between the sun and moon as seen from the earth), *qingmengqicha* (Ch. 清蒙氣差), or atmospheric refraction, the deviation of light as it passes through the atmosphere) based upon the observation values by Giovanni Domenico Cassini (> Ch. Kaxini 噶西尼.1625-1712) and John Flamsteed (> Ch. Falande 法蘭德. 1646-1719). My point is as follows: As evidenced by the reason why the *Lixiang kaocheng houbian* was compiled and by the changes of the values of *dibanjingcha* and *qingmengqicha* in it, eclipse calculation is one of the major astronomical concerns in Qing China as with previous dynasties in China. The Emperor, who is a son of Heaven, should know and accurately predict the celestial phenomena. The theory of Western astronomy was not a crucial issue in Qing China, and just "saving the phenomena" mattered. It goes without saying that the *Mā yang rgya rtsis,* which introduces the tiny part of the *Lixiang kaocheng,* has nothing to do with theory and practice of Tychonic astronomy. It is related to Tychonic astronomy in its origin, but it does not mean that it is based upon any understanding of Tychonic astronomy.

[326] Chen Jiujin and Huang Mingxin unveiled the origin of the *Mā yang rgya rtsis* in conjunction with the *Lixiang kaocheng* and the *Lixiang kaocheng houbian*. For example, it has been pointed out by Huang and Chen (1987: 366, 383, 400) that the same eclipse limit for the judgement of an eclipse with that of the *Lixiang kaocheng houbian* is used in the *Mā yang rgya rtsis*. Since an eclipse occurs near the intersection point between the ecliptic and lunar paths, calculating the position of the intersection point and the distance of the sun and moon from the intersection point are pivotal for the judgement of the possibility of an eclipse. So, it can be a determinant showing the relationship of influencing and being influenced. However, strangely enough, Huang and Chen (1984: 68) (1987a: 561) conjecture that the first *Mā yang rgya rtsis* text, i.e. the *Rgya rtsis snying bsdus*, is a selective translation from the *Xiyang xinfa lishu* on which the *Lixiang kaocheng* is based. The claim is untenable. There may exist some possibilities: they did not peruse the *Lixiang kaocheng;* Huang and Chen (1987a) uses *Qingshigao zhi* (志) *shixianzhi* (時憲) (simply 時憲志 *Shixianzhi*), in which the algorithms of eclipse calculation based upon the *Lixiang kaocheng* and the *Lixiang kaocheng houbian* are included respectively, to explain the algorithm of the eclipse calculation in *Mā yang rgya rtsis*. That may be the reason why they could not pinpoint the parallel part between the *Lixiang kaocheng* and the *Mā yang rgya rtsis.* As a matter of fact, the *Qingshigao* was compiled in 1927. It means that even if it can enhance understanding of the algorithm in *Mā yang rgya rtsis*, but is not a good method to explain some of *Mā yang rgya rtsis*'s issues such as its origin.

Firstly, I will compare basic constants among the *Lixiang kaocheng*, the *Lixiang kaocheng houbian* and the *Mā yang rgya rtsis*. Since astronomical constants have lots of digits, it is difficult for independent astronomical systems to have the same figures without influencing and being influenced.[327] The table of the comparison among the constants in the three systems is as follows:

Table 6.

	Kangxi jiaziyuan (the system of the *Lixiang kaocheng*). He et al. (1985).	*Yongzheng guimaoyuan* (the system of the *Lixiang kaocheng houbian*). Kögler and Pereira (1985).	*Mā yang rgya rtsis*: epoch 1743/12/0 (according to Tibetan *grub rtsis* calendar)
length of tropical year (*huiguinian* 回歸年)	365.2421875 days	365.24233442 days	$365\frac{60}{247} = 365.2429149$ days (*nyin zhag*)
length of synodic month (*shuoce* 朔策)	29.530593 days	29.53059053 days	*tshes zla'i rtag longs* $= 29^{d}$ (days) 12^{h} (hours) 44'3"3"'111"" (30/24/60/60/60/360)[328] $=$ 29.53059 days

[327] For the *Lixiang kaocheng Kangxi jiaziyuan*, see He et al. (*SKQS,* vol. 790) (1985: 644-7): *yueshi yongshu* (月食用數 *yongshu* (用數 numbers needed for calculation)), He et al. (1985: 674-5): constants and quantities for solar eclipse *rishi yongshu* (日食用數), Zhao (1976-1977: 1745-7). For the *Lixiang kaocheng houbian Yongzheng guimaoyuan*, see Kögler and Pereira (1985: 194-5): *yueshi yongshu*, Kögler and Pereira (1985: 227): *rishi yongshu*; Zhao (1976-1977: 1793-4. *Juan* (卷) 51, *zhi* (志) 26, *shixian* (時憲) 7). For *Mā yang rgya rtsis*, see Huang and Chen (1987a: 523-4).

[328] (30(day)/24(hour. *dus*)/60(*thun*)/60(*srang*)/60(*cha*)), 6 measurement units: (30/24/60/60/60/360), and 7 measurement units: (30/24/60/60/60/360/30). It is easily recognized that the temporal values are already transformed in Tibetan notation.

Table 6 (continued)

mean motion of the sun per synodic month (*taiyang pingxing shuoce* 太陽平行朔策)	104784".304324[329]		*nyi ma'i spyi 'gros dhru wa* = 29°6'24"15"'103"" (30/60/60/60/360/)[330] 104784".2547685)[331] : *tshes zla gcig gi longs spyod* (angular distance of one *tshes zla*)
argument from the sun's movement per synodic month (*taiyang yinshu shuoce* 太陽引數朔策)	104779".358865[332]		*nyi ma'i rang 'gros dhru wa* = 29°6'19"9"'242"" (30/60/60/60/360/) (= 104779".1612037) : *tshes zla gcig gi longs spyod*
argument from the moon's movement per synodic month (*taiyin yinshu shuoce* 太陰引數 朔策)	92940".24859[333]		*zla ba'i rang 'gros dhru wa* 25°49'0"3"'317"" (12/30/60/60/60/360/) (= 92940".064675925) : *tshes zla gcig gi longs spyod*

[329] See He et al. (1985: 644b): the value of *taiyang pingxing shuoce* (太陽平行朔策) = 104784".304324 .

[330] The units used — the same with the modern unit — are as follows: 1^g (zodiac) = 30° , 1° (T. *du'u / zhag*) (Ch. *du* 度. 1° = 3600"), 1'(arcminute) = 60" (arcsecond), 1"' = $\frac{1}{60}$", 1"" = $\frac{1}{21600}$" . 1 *du'u* = 4.5 *yul gyi chu tshod* in *skar rtsis*. (one *khyim* = 30° = 135 *yul gyi chu tshod*). Mi pham (2012a: 280) also presents them; the figures given in it are incorrect. See also Huang (1987a: 523-5). Also compare this table with the table in pp. 318-9.

[331] The value is nearly the same as that of the *Lixiang kaocheng*. The difference between the Chinese one and the *Mā yang rgya rtsis* one (transformed into decimal numbers in the above cell) derives from the Tibetan notation (see above) of the original *Lixiang kaocheng* value. In other words, Tibetans are not used to decimal numbers. They probably found the most equivalent numbers in the Tibetan system in order to approximate the Chinese decimal numbers.

[332] He et al. (1985: 644b). The *shuoce* (朔策) is the length of the synodic month. The "lunation factor" is given in Sivin's rendering. See Sivin (2009: 391-2). The *taiyang yinshu shuoce* is the sun's argument during the period of the synodic month. The half-month value is *wangce* (望策). For *wangce*, see below note 725.

[333] He et al. (1985: 645a): the value of *taiyin yinshu shuoce* (太陰引數 朔策) = 92940".24859 .

Table 6 (continued)

moon's distance from the Rāhu per synodic month (*taiyin jiaozhou shuoce* 太陰交周朔策)	110414".016574[334]	110413".92441334	*rwa* (*rā*) *gdong bar khyad dhru wa* = $1^{z}0°40'13''55'''167''''$ (12/30/60/60/60/360/) (= 110413".924398248)[335] : *tshes zla gcig gi longs spyod*

In absorbing the Chinese tradition, the Tibetan calculations still use integers, but do not use fractions. For example, length of tropical year $= 365\frac{60}{247}$, not 365.2421875 days as in the *Lixiang kaocheng* system nor 365.24233442 days as in the *Lixiang kaocheng houbian* system. This means that the differences of fractional values caused by the Tibetan intepretation are inevitable, and it is difficult to judge from astronomical constants the similarity between the two Chinese systems. At this point, we have no choice but to postpone a final decision.

Secondly, I present powerful evidence: The astronomical tables of the *Lixiang kaocheng* and the *Lixiang kaocheng houbian* are in accord with those of the *Mā yang rgya rtsis*. The comparisons of the tables are as follows:

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334 He et al. (1985: 645a): the value of *taiyin jiaozhou shuoce* (太陰交周 朔策) = 110414".016574 .

335 It is close to that of the *Lixiang kaocheng houbian*.

Table 7.

Lixiang kaocheng biao (*SKQS* 791) He et al. (1985a)	*Lixiang kaocheng houbian* (*SKQS* 792) Kögler and Pereira (1985)	Dme shul Chos 'phel's table [336]
(1985a: 20-6): *taiyang junshu biao* 太陽均數表 not the same with *Mā yang rgya rtsis*.	**(1985: 294-303): *taiyang junshu biao***	{*kha*} *nyi ma'i snon phri'i longs spyod kyi re'u mig* : the same with the ***Lixiang kaocheng houbian*** with simplifications.
(1985a: 66-72): *taiyin chujun biao* 太陰初均表	(1985: 393-412) : *taiyin chujun biao*	{*ga*} *zla ba'i snon phri'i longs spyod kyi re'u mig* : the same with the ***Lixiang kaocheng biao*** with simplifications with some wrong copies.
(1985a: 31-4): *huangchi shengdu biao* 黄赤升度表	(1985: 308-11): 黄赤升度表	{*nga*} *nyi ma'i gnam thig dmar ser mnyam bgrod zhag gi re'u mig*. Newly inserted. I do not know when they were inserted. copied the ***Lixiang kaocheng biao.*** slightly diffent values in the *Lixiang kaocheng houbian.*
(1985a: 39-40): *junshu shicha biao* 均數時差表 [337]	**(1985: 314-5): *junshu shicha biao***	{*ca*} *snon phri'i dus kyi dman cha'i re'u mig* : the same with the ***Lixiang kaocheng houbian***
(1985a: 37-8): *shengdu shicha biao* 升度時差表	**(1985: 312-3): 升度時差表**	{*cha*} *mnyam bgrod zhag gi dus kyi dman cha'i re'u mig* : the same with the ***Lixiang kaocheng houbian.*** No big difference between the ***Lixiang kaocheng biao*** and the ***Lixiang kaocheng houbian***
(1985a: 75-8): *huangbai judu biao* 黄白距度表	(1985: 440-4): *huangbai juwei biao* 黄白距緯表	{*ja*} *rā zla'i bar khyad zhag gi re'u mig* : The same with the ***Lixiang kaocheng biao*** in a simplified format.
(1985a: 299-300): *yuejuri shixing biao* 月距日實行表		{*nya*} *nyi zla'i bar khyad nges bgrod kyi re'u mig* : the same with the ***Lixiang kaocheng biao***

[336] All the *Mā yang rgya rtsis* texts use the same tables. It seems that the tables must have been copied after the *Lixiang kaocheng houbian* was compiled (i.e. 18th century), but I do not know whether they existed or not around when the *Rgya rtsis snying bsdus* was written. And Dme shul Chos 'phel's tables [= The calculational tables appended to Dme shul Chos 'phel's *Snang byed zung gi sgrib yol sogs brtag thabs shes rab ral gri'i 'od zer*] included in Huang and Chen (1987a) look to be a later copy, given the physical status of its handwriting.

[337] He et al. (1985: 157-8). The table of time difference (Ch. *Shichabiao* 時差表) is one table (Ch. *Richabiao* 日差表) in the *Chongzhen lishu* and the *Xiyang xinfa lishu* [> M. *Tngri-yin udq-a* / T. *Rgya rtsis chen mo*], but it was divided into two tables *Shengdushichabiao* (升度時差表) and *Junshushichabiao* (均數時差表) in the *Lixiang kaocheng* for the purpose of increasing the accuracy. For more information, see Chen1 (2003: 668). The *Mā yang rgya rtsis* is also based upon the *Lixiang kaocheng*. Then, it may be safely assumed that the *Mā yang rgya rtsis* cannot be a continuation or creation of the *Rgya rtsis chen mo*. It is a mere duplicate of the *Lixiang kaocheng* in terms of the tables and the method of their use.

Table 7 (continued)

(1985a: 79-80): *huangbai shengducha biao* 黄白升度差表	(1985: 436-9): 黄白升度差表	*{ta} rā zla'i bar khyad mnyam bgrod zhag gi dman cha'i re'u mig* : the same with the ***Lixiang kaocheng biao.***
(1985a: 305-8)[338] : *shibanjing biao* 視半徑表		*{tha} zla ba'i phyed srid kyi re'u mig* : the same with the ***Lixiang kaocheng biao.***
(1985a:305-8): 視半徑表		*{da} grib ma'i phyed srid kyi re'u mig* : the same with the ***Lixiang kaocheng biao.***
(1985a: 305-8): 視半徑表		*{na} grib ma'i dman cha'i re'u mig*: the same with the ***Lixiang kaocheng biao.***
(1985a: 309-317): *jiaoshi yuexing biao* 交食月行表		*{pa} gza' 'dzin zla bgrod kyi re'u mig*: the same with the ***Lixiang kaocheng biao.***
(1985a: 305-8): 視半徑表	(1985: 456-7)	*{pha} nyi ma'i phyed srid kyi re'u mig*: the same with the ***Lixiang kaocheng biao.*** with some wrong copies.
(1985a: 305-8): 視半徑表	(1985: 466-9): *Taiyin dibanjingcha biao* 太陰地半徑差表	*{ba} zla sa'i phyed srid bar khyad kyi re'u mig* :[339]
(1985a: 319-510): **h*uangpingxiangxian biao*** **黄平象限表**	n/a	*{ma} bgrod mnyam bar khyad kyi re'u mig*
		{*tsa*} missing
(1985a: 557-68): *dongxinanbeicha biao* 東西南北差表		*{tsha} dus cha'am shar nub lho byang dman cha'i re'u mig* : the same with the ***Lixiang kaocheng biao.*** in a simplified format.

[338] The differences between the *Lixiang kaocheng* and the *Lixiang kaocheng houbian* include the values of the apparent diameter of the sun and moon, the earth's distance to the sun and moon at syzygies with resepct to the semi-diameter of the earth, etc. The values of the latter are much more accurate, showing a drastic difference from those of the former and the *Xiyang xinfa lishu*, and must have contributed to the accuracy of eclipse calculation. For more information, see Hashimoto (1971: 263-4). However, the *Mā yang rgya rtsis* uses the *shibanjing biao* in the *Lixiang kaocheng*, not in the *Lixiang kaocheng houbian*. I do not know why, but it does seem that although the author of the first *Mā yang rgya rtsis* (= *Rgya rtsis snying bsdus*) knew the crucial importance of incorporating the unprecedented factors in Tibet, he probably did not know the astronomical significance of the change or did not seek to be very accurate in eclipse calculation. Or, he may have adopted the widespread method at that time in Beijing. As a matter of fact, it is known that whatever method is used betweeen the *Lixiang kaocheng* and the *Lixiang kaocheng houbian*, the results would not make a big difference. It may be a reason, too.

[339] The values are different from, but are closer to, the *Lixiang kaocheng*. Specialists in the field of Qing China astronomy would surely know why.

The bold fonts indicate the original tables of the *Mā yang rgya rtsis*. My conclusion is that the *Mā yang rgya rtsis* selectively chose the tables from both Chinese systems.[340] It also means that the *Mā yang rgya rtsis* came into being after the *Lixiang kaocheng houbian*, which is the last calendrical system in Qing China. Moreover, it implies no relevance to the *Rgya rtsis chen mo*.[341] It is mostly based upon the *Lixiang kaocheng*. In addition, I should stress that the two Chinese texts are filled with more complex tables. The *Mā yang rgya rtsis* singled out the indispensable tables for eclipse calculation, with simplification in some cases. Chinese astronomy specialists would immediately recognize, by merely looking at the above table, how the computation is made in the *Mā yang rgya rtsis*: Semi-diameter of the sun and moon, semi-diameter of the earth's shadow, parallax computation through the table of the nonagesimal (the *huangpingxiangxian biao*) are immediately speculated.

[340] At this point, the relationship between the *Lixiang kaocheng* and the *Lixiang kaocheng houbian* should be noted: the *Lixiang kaocheng houbian* was used as a supplement to the *Lixiang kaocheng* in the Manchu dynasty. Regardless of the revolutionary Kepler's first law (all planets move in elliptical orbits with the sun as one focus) in the Western context, it was understood as a mathematical device to enhance the accuracy of astronomical calculations in the *Lixiang kaocheng houbian* system. In other words, it was believed that if the elliptical orbit is applied to calculate *richan* (movement of the sun) and *yueli* (movement of the moon), the results would be more accurate than the *Lixiang kaocheng*. And the expositions on the movement of the five planets are not included in the *Lixiang kaocheng houbian*, which means that it still uses those of the *Lixiang kaocheng*. Simply put, after 1742 in the Manchu dynasty, calculations of sun, moon, and eclipse are based upon the values of the *Lixiang kaocheng houbian* system without fundamental differences in calculation methods from the *Lixiang kaocheng,* and the planetary movement is based upon the system of the *Lixiang kaocheng*. The main reason is that the *Lixiang kaocheng houbian* system focuses on the improvement of the *Lixiang kaocheng* system, which has demonstrated problems in eclipse calculation. The practice in contemporary China may be related to the *Mā yang rgya rtsis* in terms of the choice of the tables.

[341] To verify this, I should present the difference of the tables between the *Xiyang xinfa lishu* (*Rgya rtsis chen mo*) and the *Lixiang kaocheng*/ *Lixiang kaocheng houbian*, but it is beyond my scope. However, I would say that Chinese astronomy specialists would agree with me in terms of the different tables between the *Xiyang xinfa lishu* and the *Lixiang kaocheng*/ *Lixiang kaocheng houbian*. My point is that Huang and Chen (throughout their writings), Badzra (2003a) in which the continuation / creation of the *Mā yang rgya rtsis* from the *Rgya rtsis chen mo* cannot be justified.

Thus the tables, not real mathematical calculations or theoretical bases, play a big role in eclipse calculation in the *Mā yang rgya rtsis*. At any rate, it is evident that the system would be different from the *skar rtsis* method in terms of eclipse calculation.

I present more evidence: An algorithm. The *Rgya rtsis snying bsdus* is a duplicate of the algorithm for eclipse calculation in the *Lixiang kaocheng*.[342] The algorithm in the *Mā yang rgya rtsis* is basically identical to that in the *Lixiang kaocheng*.[343] This means that the first *Mā yang rgya rtsis* text, the *Rgya rtsis snying bsdus*, is not a continuation of the *Rgya rtsis chen mo.* It uses another Chinese text, the *Lixiang kaocheng*, which has basically the same mathematical bases as the *Xiyang xinfa lishu* (the original text of *Mā yang rgya rtsis*). It is reasonable say that it has no relevance to the *Tngri-yin udq-a* / *Rgya rtsis chen mo*.

Whether or not the research into Chinese eclipse calculation methods may be closely tied to religious reasons such as *bstan rtsis*, *gso sbyong* is unknown. I have not found any textual evidence yet for such a link.

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[342] See below note 654. Given its algorithm, *Mā yang rgya rtsis*'s Chinese original text leaves no other option except for the *Lixiang kaocheng*. For the peculiarities of the *Lixiang kaocheng* method among the Chinese methods used in Qing China, see below note 654.

[343] The simplications in the algorithm and the use of *huangpingxiangxian* not *baipingxiangxian* in the *Mā yang rgya rtsis* should be mentioned. See chapter 4.

2.5. POLITICAL SUPPORT

According to Schuh, *grub rtsis* of the *Phug* system was accepted by the *Phag mo gru* government for 15th century Tibetan astronomy.[344] The *Rgya rtsis chen mo* may be filed under the category of political concern because it came into existence due to Manchu political concerns in the 18th century, especially in conjunction with eclipse calculations.

TNGRI-YIN UDQ-A / RGYA RTSIS CHEN MO

The original text of the *Tngri-yin udq-a*[345]/ the *Rgya rtsis chen mo* is the *Xiyang xinfa lishu.* There are some chapters which original texts are not identified in the *Tngri-yin udq-a*/ *Rgya rtsis chen mo*.[346] The translated chapters from the *Xiyang xinfa lishu* (1645) are not

[344] Schuh (1974: 562-3).

[345] The text has different Mongolian titles. In *Mongγol ündüsüten-ü bürin toli* (2007: 1313), four titles are given: *toγan-u uqaγan-u oki sain čobural bičig*, *odun oron čaγ ularil-i boduqu ǰingkini nom*, *engke amuγulang qaγan-u ǰokiyaγsan kitad čaγ ularil-un quriyangγui nom-un mongγol orčiγulγa-yin debter*, and *engke amuγulang qaγan-u ǰokiyaγsan kitad čaγ ularil-un bičig-ün quriyangγui*. Čeden, Suwadi and Sarantuyaγ-a (1988: 68) gives the following three titles: *Solbičan bariqu-yin bodurul bičig* / (Ch. *Jiaoshibiao* 交食表), *ǰiruqai-yin γoul* (Ch. *Shulijingyi congshu* 數理精儀叢書), and *Tngri-yin udq-a* (Ch. *Tianwen yuanli* 天文原理). Also see Čeden et al. (1990: *oroγulburi* (lit. insertion), 1). Each chapter has a title, but the title of the whole text has not been given. Moreover, an incomplete version (for example, just some chapters of it) has been circulated. The whole text was computer-typed by Čeden et al. (1990) after the extant prints were collected and compared. The problem in the appellation of the text continues in its Tibetan translation, the so-called *Rgya rtsis chen mo*. The Tibetan title of the whole text is not given, even if it has been called as such.

[346] For the *Tngri-yin udq-a*, see Čeden et al. (1990: *oroγulburi*, 5). For the *Rgya rtsis chen mo*, see Huang and Chen (1987: 572-5) and Lobsang Yongdan (2015: 190-6) with some errors: misidentification of the Chinese parallel parts and wrong order of the Tibetan chapters. Huang and Chen (1987) are basically correct. It uses the *Xinfa suanshu* to present parallel parts in the *Rgya rtsis chen mo*. But, the following minor fact should be also considered. In 1629 (*Chongzhen* 2nd year), the Bureau of Astronomy (Ch. *liju* 歷局) was established for

theoretical but practical for eclipse calculations, containing mostly calculational tables. In other words, *Richanbiao* (日躔表) and *Yuelibiao* (月離表), *Jiaoshibiao* (交食表), which are the calculation tables, were included in the *Tngri-yin udq-a*/ *Rgya rtsis chen mo* for actual eclipse calculation. However, their individual theoretical parts, i.e. *Richanlizhi* (日躔歷指), *Yuelilizhi* (月離歷指), and *Jiaoshilizhi* (交食歷指) were not translated. The Mongolian translation was designed for practical use, but no evidence exists showing that it has been actually used by Mongolians. The comparison table of the three different language versions (Chinese-Mongolian-Tibetan) is as follows:

Table 8.

	Chinese *Xiyang xinfa lishu* [= *Xinfa suanshu*]	Mongolian *Tngri-yin udq-a*[347]	Tibetan *Rgya rtsis chen mo* (1715/1716)
1[348]	n/a	1.[349] *ǰiruqai-yin orusil* (1990: 1-3)	n/a

the revision of the calendar, and the *Chongzhen lishu* composed of 137 *juan*-s was completed in 1634 (*Chongzhen* 7th year). Unfortunately, they have not been found until now. Therefore, the *Chongzhen lishu* we now have access to is different from the first edition. Moreover, the *Chongzhen lishu* was reedited by Adam Schall von Bell (Ch. Tang Ruowang 湯若望) into the *Xiyang xinfa lishu* and began to be used in 1645. See Hashimoto (1988: especially, 28-52 and 64-8). And then, it was renamed *Xinfa suanshu* when it was included in *SKQS* in Abkai wehiyehe Qianlong 37th year (1772). For more information, see Hashimoto (1988: 62-4). In other words, rather than the *Xinfa suanshu*, the *Xiyang xinfa lishu* is the Chinese original of the *Tngri-yin udq-a* and the *Rgya rtsis chen mo.*

347 For a modern version, see Čeden et al. (1990). The text is composed of 5 volumes (M. *debter*): *nigedüger debter:* chapters 1-7, *qoyaduɣar debter* : chapters 8-13, *ɣurbaduɣar debter*: chapters 14-22, *dörbedüger debter*: chapters 23-32, and *tabuduɣar debter*: chapters 33-38.

348 The parallel chapters in the different languages are written in the same row in this table.

349 I followed Čeden et al. (1990) in the numbering.

Table 8 (continued)

2	*Richanbiao* (日躔表) chapter (Ch. *juan* (卷)) 1 (2000: vol. (Ch. *ce* (册)) 4: 57a-94b) [= (1983: vol. (Ch. *ce* (册)) 788: chapter *(Ch. juan* (卷)*)* 25, 392a-429a)]	*2. naran-u kerükü-yin bodurul nigedüger* (1990: 5-60)	1. [350] *ka*: *nyi ma myul ba'i ngos 'dzin*[351] *gyi glegs bam dang po* 32 fols.
3	*Richanbiao* chapter 2 (2000: vol. 4: 95a-117b) [= (1983: chapter 26, 430a-454a)]	3. *naran-u kerükü-yin bodurul qoyaduγar* (1990: 61-84)	2. *kha*: *nyi ma myul ba'i ngos 'dzin gyi glegs bam gnyis pa* 22 fols.
4	*Yuelibiao* (月離表) chapter 1 (2000: vol. 4: 200a-216a) [= (1983: chapter 32, 560a-576b)]	4. *saran-u tuγulqu-yin bodurul nigedüger* (1990: 86- 107)	3. *ga*: *zla ba brgal ba'i ngos 'dzin / glegs bam dang po /* 23 fols.
5	*Yuelibiao juan* 2 (2000: vol. 4: 216b-229b) [= (1983: chapter 33, 577a-589b)]	5. *saran-u tuγulqu-yin bodurul qoyaduγar* (1990: 109-23)	4. *gha*[352]: *zla ba brgal ba'i ngos 'dzin / glegs bam gnyis pa /* 17 fols.
6	*Yuelibiao juan* 3 (2000: vol. 4: 230a-247a) [= (1983: chapter 34, 590a-606b)]	6. *saran-u tuγulqu-yin bodurul γurbaduγar* (1990: 124-40)	5. *nga*: *zla ba brgal ba'i ngos 'dzin / glegs bam gsum pa /* 18 fols.

[350] The numbering is based upon the Tibetan print. The Tibetan version is *verbatim ac litteratim* translation of the Mongolian one, but the order of the former is occasionally different from that of the latter. See the order of the chapters 22, 23, 35, 36, and 37 in the above table! When I perused the Mongolian print in Öbör *mongγol-un neigem-ün sinjilekü uqaγan-u nom-un sang*, I saw that each volume (5 volumes in total) is in a book-bound format. If the Mongolian lamas who translated the *Tngri-yin udq-a* into the *Rgya rtsis chen mo* just followed the Mongolian order, there would not have been such difference. Thus, there may be several possibilities. Perhaps the original Mongolian print was not bound in a book format when it was delivered to the translators. Or, the Tibetan translators were not meticulous. It is certain that they did not or could not meticulously translate the Mongolian text partly because of lack of knowledge. Or, there may exist other possibilities. It is difficult to pinpoint the reason at present.

[351] *ngos 'dzin* (lit. recognition) is used to render *biao* (表)/ M. *bodurul*. It is problematic.

[352] It seems that the strange Tibetan alphabets were devised to number 37 chapters —excluding the colophon—. The Tibetan 30 consonants from *ka* to *a* are not enough to number 37. It is possible that my reading the Tibetan alphabet may be wrong because there exist strange letters. The Chinese numbers written in the right margin in each folio help to ascertain the exact number of each chapter.

Table 8 (continued)

7	*Yuelibiao juan* 4 (2000: vol. 4: 247b-272b) [= (1983: chapter 35, 607a-632a)]	7. *saran-u tuγulqu-yin bodurul dörbedüger* (1990: 141-64)	6. *tsa*: *zla ba brgal ba'i ngos 'dzin / glegs bam bzhi pa /* 25 fols.
8	*Wuweibiao* (五緯表) *juan*-s 1 and 2. *Tuxing* (土星) *shangxia* (上下). (2000: vol. 3: 259b-293b) [= (1983: chapters 46 and 47, 795a-830a)]	8. *saničar graγ-un bodurul* (Saturn) (1990: 165-97)	7. *tsha*: *gza' spen pa'i ngos 'dzin* 34 fols.
9	*Wuweibiao juan*-s 3 and 4. *Muxing* (木星) *shangxia* (2000: vol. 3: 294a-327a) [= (1983: chapters 48 and 49, 830b-864b)]	9. *barqasbadi graγ-un bodurul* (Jupiter) (1990: 199-231)	8. *dza'*: *gza' phur bu'i lo nyis brgya yun gyi ngo 'dzin*[353] 25 fols.
10	*Wuweibiao juan*-s 5 and 6. *Huoxing* (火星) *shangxia* (2000: vol. 3: 327b-357a) [= (1983: chapter 50 and 51, 865a-895b)]	10. *anggharaγ graγ-un bodurul* (Mars) (1990: 232-65)	9. *dzha'*: *gza' mig dmar gyi lo nyis brgya yun gyi snyoms 'gros kyi ngos 'dzin*[354] 33 fols.
11	*Wuweibiao juan*-s 7 and 8. *Jinxing* (金星) *shangxia* (2000: vol. 3: 357b-389b) [= (1983: chapters 52 and 53, 896b-928a)]	11. *šukar-a graγ-un bodurul* (Venus) (1990: 266-99)	10. *nya*: *gza' pa sangs kyi ngos 'dzin* 31 fols.
12	*Wuweibiao juan*-s 9 and 10. *shuixing* (水星) *shangxia* (2000: vol. 4: 1a-32b) [= (1983: chapters 54 and 55, 929a-961b)]	12. *bud graγ-un bodurul* (Mercury) (1990: 300-30)	11. *ṭa*: *gza' lhag pa'i ngos 'dzin* 32 fols.
13	*Wuweibiao juan* (卷) *shou* (首) (2000: vol. 3: 236b-259a) [= (1983: chapter 45, 774a-794b)].	13. *tabun köndelekü-yin bodurul* (1990: 331-75)	12. *ṭha*: *'phred pa lnga'i ngos 'dzin* 29 fols.

353 The *kha byang* was not carved independently. The title is given in the upper margin in the first folio.

354 The *kha byang* was not carved independently. The title is given in the upper margin in the first folio.

Table 8 (continued)

14	*Jiaoshibiao juan* 1 (交食表卷 1) (2000: vol. 2: 38a-64a) [= (1983: chapter 72, 295a-320b)]	14. *solbičan bariqu-yin bodurul nigedüger*[355] (1990: 377-406)	13. *ḍa*: *bsnol bar 'dzin pa'i ngos 'dzin / glegs bam dang po /* 25 fols.
15	*Jiaoshibiao juan* 2 (2000: vol. 2: 64b-88a) [= (1983: vol. 789: chapter 73, 321a-343b)]	15. *solbičan bariqu-yin bodurul qoyaduγar* (1990: 407-34)	14. *ḍha*: *bsnol bar 'dzin pa'i ngos 'dzin / glegs bam gnyis pa /* 26 fols.
16	*Jiaoshibiao juan* 3 (2000: vol. 2: 88b-108a) [= (1983: vol. 789: chapter 74, 344a-364a)]	16. *solbičan bariqu-yin bodurul γurbaduγar* (1990: 435-509)	15. *ṇa*: *bsnol bar 'dzin pa'i ngos 'dzin / glegs bam gsum pa /* 38 fols.
17	*Jiaoshibiao juan* 4 (2000: vol. 2: 108b-127b) [= (1983: vol. 789: chapter 75, 364b-383b)]	17. *solbičan bariqu-yin bodurul dörbedüger* (1990: 511-85)	16. *ta*: *bsnol bar 'dzin pa'i ngos 'dzin/ glegs bam bzhi pa /* 38 fols.
18	*Jiaoshibiao juan* 5 (2000: vol. 2: 128a-156b) [= (1983: vol. 789: chapter 76, 384a-412b)]	18. *solbičan bariqu-yin bodurul tabuduγar* (1990: 586-616)	17. *tha*: *bsnol bar 'dzin pa'i ngos 'dzin / glegs bam lnga pa /* 31 fols.
19	*Jiaoshibiao juan* 6 (2000: vol. 2: 157a-184a) [= (1983: vol. 789: chapter 77, 413a-439b)]	19. *solbičan bariqu-yin bodurul ǰirγuduγar* (1990: 617-45)	18. *da*: *bsnol bar 'dzin pa'i ngos 'dzin / glegs bam drug pa /* 29 fols.
20	*Jiaoshibiao juan* 7 (2000: vol. 2: 184b-201a) [= (1983: vol. 789: chapter 78, 440a-456b)]	20. *solbičan bariqu-yin bodurul doluduγar* (1990: 646-62)	19. *dha*: *bsnol bar 'dzin pa'i ngos 'dzin / glegs bam bdun pa /* 20 fols.
21	*Jiaoshibiao juan* 8 (2000: vol. 2: 201b-221a) [= (1983: vol. 789: chapter 79, 457a-476a)]	21. *solbičan bariqu-yin bodurul naimaduγar* (1990: 663-89)	20. *na*: *bsnol bar 'dzin pa'i ngos 'dzin / glegs bam brgyad pa /* 18 fols.

355 The *solbičan bariqu* looks to be a literal rendering of the Chinese term *jiaoshi.* For another expression seen in *Tngri-yin udq-a*, see below note 362. The mostly-used Mongolian terms are *naran bariqu* (solar eclipse) and *sara bariqu* (lunar eclipse). They seems to date back to earlier time. A 14th century use of the terms is found in an Arabic manuscript (Bibliothèque nationale Paris, Fonds Arabe No. 6040) in which solar and lunar eclipse calculation tables are included. The author is Abū Muḥammad 'Aṭā (1290?-) during the period of Chagatai Khanate. Franke (1988: 98): "... Hierbei sind in vielen Fällen die arabischen astronomischen Fachworte nicht übersetzt, sondern nur transkribiert, was sicher darauf zurückzuführen ist, dass es im damaligen Mittelmongolisch der Zeit um 1369-1370 dafür keine mongolischen Äquivalente gab." Nevertheless, the Mongolian expressions were used for eclipses. See Franke (1988: 100): fol. 42b. *naran bariqu*, fol. 44a: *sara bariqu*. Modern Mongolian terms are as follows: *nara gkirtükü* (solar eclipse) and *sara gkirtükü* (lunar eclipse).

Table 8 (continued)

22	*Jiaoshibiao juan* 9 (2000: vol. 2: 221b-245b) [= (1983: vol. 789: chapter 80, 476b-500a)]	22. *solbičan bariqu-yin bodurul yisüdüger* (1990: 690-719)	21. *pa*: *bsnol bar 'dzin pa'i ngos 'dzin / glegs bam dgu pa /* 28 fols.
23	n/a	23. *nemegsen bodurul-un uγ ijaγur-un jiruγ-un kelelge* (1990: 721-36)	23. *ba*: *bsnan pa'i ngos 'dzin gyi 'byung 'khungs kyi ri mo'i brjod pa* 10 fols.
24	n/a	24. *nemegsen solbičan bariqu-yin bodurul döčin qoyar qonuγ*[356] (1990: 737-57)	22. *pha*: *bsnan pa'i bsnol 'dzin gyi ngos 'dzin / zhag zhe gnyis pa /* 15 fols.
25	n/a	25. *nemegsen solbičan bariqu-yin bodurul döčin dörben qonuγ* (1990: 758-74)	24. *bha*: *bsnan pa'i bsnol 'dzin gyi ngos 'dzin / zhag zhe bzhi pa /* 12 fols.
26	n/a	26. *nemegsen solbičan bariqu-yin bodurul döčin jirγuγan qonuγ* (1990: 775-91)	25. *ma*: *bsnan pa'i bsnol 'dzin gyi ngos 'dzin / zhag zhe drug pa /* 12 fols.
27	n/a	27. *nemegsen solbičan bariqu-yin bodurul döčin naiman qonuγ* (1990: 792-808)	26. *ya*: *bsnan pa'i bsnol 'dzin gyi ngos 'dzin / zhag zhe brgyad pa /* 12 fols.
28	n/a	28. *nemegsen solbičan bariqu-yin bodurul tabin qonuγ* (1990: 809-25)	27. *ra*: *bsnan pa'i bsnol 'dzin gyi ngos 'dzin / zhag lnga bcu pa /* 12 fols.
29	n/a	29. *nemegsen solbičan bariqu-yin bodurul tabin dörben qonuγ* (1990: 826-42)	28. *la*: *bsnan pa'i bsnol 'dzin gyi ngos 'dzin / zhag nga bzhi pa /* 12 fols.

[356] The chapters 24-32 in the *Tngri-yin udq-a* are for Mongolian use. Geographical knowledge is necessary for eclipse (especially solar eclipse) calculation and it seems that they are related to the real measurement of the latitude and longitude of the Mongolian regions made during Elhe Taifin Kangxi's time. Even if they were also translated into Tibetan (incidentally, they are useless for the Tibetan areas, e.g., latitude in Lhasa is 29°), the latitudes selected (42°, 44°, 46°, 48°, 50°, 54°, 58°, 62°, 66°) explain that the *Tngri-yin udq-a* was designed to enhance the accuracy of eclipse calculations in Mongolia, where the inaccurate Tibetan *skar rtsis* method (no geographical consideration) was used. Read the preface of the *Tngri-yin udq-a* together with these tables! Then, where do the chapters derive from? It may need an investigation into the history of latitude and longitude in Manchu dynasty, which is a huge topic involving cartography and geographical knowledge at that time. It is beyond my scope here. For more information, see *Qingting sanda shice quantuji* (2007), du Halde (1735: 473-88), Ding, Tan, Luo and Li (1977: 29-45), Foss (1988: 209-51), and Yee (1994: 35-231). For the measurement of the latitude and longitude in Tibetan areas in Manchu dynasty, no professional research has been made as far as I know. Some fragmentary facts are known to us through a classical study by Fuchs (1943), which presents maps such as a map of Lhasa (No. 13), a map of Brahmaputra/ Yar klungs gtsang po (No. 14), a map of Kailāśa/Gangs rin po che (No. 15), etc.. And Fuchs (1943: 12) and Lobsang Yongdan (2015: 185-6) mention Chu'erqin zangbu (楚儿沁藏布 < T. Tshul khrims bzang po) who was dispatched to Tibet in 1717 for the geographical measurement of Tibet. For the history of the measurement of the latitude and longitude of Mongolia, there are some articles. Especially see Hasibagen (2010: 92-6).

Table 8 (continued)

30	n/a	30. *nemegsen solbičan bariqu-yin bodurul tabin naiman qonuγ* (1990: 843-59)	29. *wa*: *bsnan pa'i bsnol 'dzin gyi ngos 'dzin / zhag nga brgyad pa /* 12 fols.
31	n/a	31. *nemegsen solbičan bariqu-yin bodurul ǰiran qoyar qonuγ* (1990: 860-76)	30. *sha*: *bsnan pa'i bsnol 'dzin gyi ngos 'dzin / zhag re gnyis pa /* 12 fols.
32	n/a	32. *nemegsen solbičan bariqu-yin bodurul ǰiran ǰirγuγan qonuγ* (1990: 877-93)	31. *ṣa*: *bsnan pa'i bsnol 'dzin gyi ngos 'dzin / re drug pa /* 12 fols.
33	n/a	33. *Tngri-yin udq-a-yin alqum-un domuγ-un γarcaγ* (1990: 895-918)	32. *sa*: *gnam don gyi tshad bshad pa.*[357] 14 fols
34	*baxianbiao juan shangxia* (八線表 卷 上下) (2000: vol. 4: 340a-390a) [= (1983: vol. 789: chapters 81 and 82, 501a-551b)]	34. *naiman utasun-u bodurul* (1990: 920-)	33. *ha*: *skud pa brgyad kyi ngos 'dzin* 54 fols.
35	n/a	35. *darun odqu qalun odqu-yin bodurul* (1990: 1021-)	34. *kṣa*: *mnan brnyas kyi ngos 'dzin* 11 fols.
36	n/a	36. *dürim bayidal-un ǰokiyangγui-yin bodurul* (1990: 1035-)	37. *kya* (?): *rnam pa'i bkod pa mdzad pa'i ngos 'dzin* 32 fols.
37	n/a	37. *doluγan graγ-un narin büdügübči* (1990: 1061-)	35. *kra* (?): *gza' bdun phra mo'i zin bris* 11 fols.
38	n/a	38. *solbičan bariqu-yin narin büdügübči* (1990: 1076-)	36. *kla* (?)[358]: *bsnol bar 'dzin pa'i phra mo'i zin bris* 20 fols.

[357] 3 folio *Snyoms tshad skor thig gi skar ma thams cad kyi ri mo'i bshad pa* is inserted between chapter 32 and chapter 33.

[358] *kya* / *kra* / *kla* : These appear to be the spellings which combine *k* / *ka* with *ya* /*ra* / *la* according to Tibetan alphabetical order. Even if it is the case, a problem exists: the order in Chinese (see roman numbers) does not match up with that in Tibetan.

Table 8 (continued)

39	n/a	n/a	38. *'Jam dbyangs bde ldan rgyal pos*[359] *mdzad pa'i rgya rtsis bod skad du bsgyur ba* [= *spar* (*sic.* read *par*) *byang* (printer's colophon)][360] 3 fols.

The differences between the *Tngri-yin udq-a*/ *Rgya rtsis chen mo* are as follows: The order of some chapters are different, and the *ǰiruqai-yin orusil* (preface) in the *Tngri-yin udq-a* is included only in the *Tngri-yin udq-a*; the printer's colophon in the *Rgya rtsis chen mo* is included only in the *Rgya rtsis chen mo.*[361]

CRITICISM OF TIBETAN *SKAR RTSIS* ECLIPSE CALCULATIONS IN THE PREFACE OF THE *TNGRI-YIN UDQ-A*

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359 For the appellation of Elhe taifin Kangxi Emperor in Tibetan, see Tuttle (2011: 194-5): one of the Tibetan equivalent of Elhe taifin Kangxi Emperor is *bde skyid*. Also see Karsten (unpublished: 5): *bde 'jag* is given for the title of Elhe taifin Kangxi Emperor together with *bde skyid*. And in this colophon, *bde ldan* is given as the Tibetan appellation of the Emperor. The *Tngri-yin udq-a* from which the Tibetan *Rgya rtsis chen mo* was translated addresses him as '*manǰusiri degedü amuγulang qaγan*' which is reconstructed as '*'Jam dbyangs gong ma bde ldan rgyal po*' in Tibetan and which appears later in this colophon. Thus, it is highly possible that the Tibetan appellation *bde ldan* reflects that of the Mongolian original text *Tngri-yin udq-a.* It should be also noted that both *Tngri-yin udq-a* and *Rgya rtsis chen mo* were created by Mongolian lamas.

360 The *rgyal pos mdzad pa* is the rendering of the Chinese *yuzhi* (御製). It does not mean "emperor's work." Rather, it means "imperally commissioned/ imperially published". So, *'Jam dbyangs bde ldan rgyal pos mdzad pa'i rgya rtsis bod skad du bsgyur ba* means "the Tibetan translation of the Chinese astronomy which was imperially commissioned by Mañjuśrī Kangxi Emperor."

361 For the translations, see Appendix III.

Much information is included in the preface of the *Tngri-yin udq-a.* The preface begins with an overview of the history of the Tibetan *skar rtsis*. (See appendix II). It also clearly demonstrates criticism of Tibetan *Kālacakra* / *skar rtsis* eclipse calculations:

> *Töbed oron-dur γadaγadu dutuγadu yerüngki-yin ǰiruqai kemekü üile-yin ǰiruqai kiged, dotuγadu yerü busu-yin ǰiruqai kemekü siddi-yin ǰiruqai, qoyar büri erten-eče delgerebečü, naran saran tüidküi*[362]*-yin čaγ möče terigüten-i γaǰar oron-u öndür boγuni kiged, naran saran erte orui urγuqui-yin kemǰiyen-dür onuǰu*[363]*bodalan*[364] *taniqu keregtei kemen nomlaγsan atala, γaǰar oron-u öndür boγuni-yin kemǰiyen-i*[365] [*Tngri-yin udq-a* (1711: 3)] *üǰeküi yosun-u arγ-a terigüten inü sudur-tur todurqai ese boluγsan-u tulada, ǰiruqayičin-nuγud-ber čaγ möče terigüten-i endegürel ügegüy-e onuqui anu berke boluγad,*
>
> In the land of Tibet, each of the two—*byed rtsis* (M. *üile-yin ǰiruqai*), known as the astronomy common to outer and inner [principles], and *grub rtsis* (M. *siddi-yin ǰiruqai*), known as the astronomy that is of inner [principles]—is not universal, but has prospered since ancient times. However, at the same time there are those [texts] which explain that it is necessary to concretely recognize the *čaγ möče* (< Ch. *shike*)[366], etc. of the solar and lunar eclipses, after one has understood by measurement the height of the place (= altitude) and the rise of the sun and moon in the morning and evening [respectively]. Because the methods and such of observing the level of the height of the place were not clear in the texts, astronomers had difficulty understanding the *shike*, etc., without error.

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362 From the context, it appears that "*tüidküi*" meaning "obstruct" is rarely used for denoting an eclipse. Such expresssions as *naran bariqu* for solar eclipse and *saran bariqu* for lunar eclipse are commonly used in Mongolian literature.

363 It looks difficult to translate "*kemǰiyen*" in "*kemǰiyen-dür onuǰu*". My suggestion is "measurement."

364 This word is rarely seen. It may be related to "*bodatai*" meaning "concrete/ substantial."

365 My suggestion for "*kemǰiyen*" in "*kemǰiyen-i üǰeküi*" is "level."

366 The "*čaγ möče*" is a literal rendering of the Chinese *shike* 時刻.

Firstly, the *skar rtsis* method is ignorant of "the height of place" (= altitude of Polaris (= latitude) in context. This looks to be a rendering of the Chinese *gaodu* 高度). It highlights that the importance of geographical knowledge in the calculation of solar eclipses was not considered in Tibet. This is a valid criticism. Secondly, the measurement of sunrise and sunset time is not proper from the perspective of modern astronomy. Sunrise and sunset time changes according to solar declination (δ) which changes according to season and φ.[367] It is necessary for deciding the time of eclipse, the status of *daishi* (带食),[368] etc. From that perspective, the prediction of an eclipse is not accurate in Tibet and Mongolia, which use the Tibetan *skar rtsis* method. All in all, it points out that the Tibetan *skar rtsis* method is not based upon firm geographical/geometric knowledge from the modern perspective. Although this is true, the above passage may also indicate that there is no deep understanding of Tibetan *skar rtsis* methods from the outside perspective.[369]

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[367] There is no solid concept of φ in *skar rtsis*. But, there is a concept of different length of day and night according to different region. Albeit very brief and inaccurate, there have been Tibetan considerations for sunrise and sunset time in the case of eclipse calculations. For example, see Sum pa Mkhan po's eclipse calculation in which the eclipse time was calculated from *nam langs* (possibly from sunrise time). See below note 536 and p. 259. This issue needs more investigation. However, if the above passage means that the Tibetan *skar rtsis* method is not based upon modern method, it is true.

[368] Sivin uses "carried eclipse" for translating the Chinese term "*daishi*". See Sivin (2009: 515): "A carried eclipse is an eclipse which takes place at sunrise or sunset, that is, in which sunrise or sunset falls between first and last contact." There are two cases: *richu daishi* (日出带食*)*, the case in which an eclipse already began before sunrise; and *rimo daishi* (日没带食), the case in which the sun sets during the progress of an eclipse).

[369] The understanding of the Tibetan calendrical system by Chinese, Mongolians, and Manchu people during the Manchu dynasty looks to be very limited. For example, see Huang1 (Huang Peiqiao 黄沛翘. active late 19th c.) (1982: 179): He seems ignorant of the Tibetan calendrical system, but is aware of the difference of the intercalation method between Tibet and China. In particular, he states that there are no errors in the calculations of solar and lunar eclipses in Tibet. His statement is groundless. Another example

In the 18th century, there existed a clear demarcation between Tibetan religious astronomy—*čaγ-un kürdün* (Mongolian *Kālacakra*)/ *odun-u ǰiruqai* (Mongolian *skar rtsis*)—and non-Tibetan non-religious Western (Chinese) astronomy, including the *Tngri-yin udq-a*, etc., in Mongolian astronomy. The former was employed by lamas and the latter by Qing court astronomers, respectively. In this context, Mongolian astronomers of the Qing court selectively chose some chapters of the *Xiyang xinfa lishu,* which are pivotal parts of the Western (Chinese) eclipse calculation based upon geometric and trigonometric methods.

THE SIGNIFICANCE OF THE *RGYA RTSIS CHEN MO* IN THE TIBETAN ASTRONOMY

The *Rgya rtsis chen mo* is a *verbatim ac litteratim* translation of the *Tngri-yin udq-a* by the Tibetan-literate Mongolian lamas in Kökeqota. Clearly, it was not understood because of the unprecedented number of new mathematical terms, concepts and technical knowledge, which had no common footing in *skar rtsis*. Most of all, there is no evidence that it was ever used. The translation makes no contribution to the expansion of

is He (Mongolian official He Ning 和寧 (alias He Ying 和瑛. ? - 1821)) (2013: 173) [= also in Huang1 (1982: 253-4)]. His understanding is better than that of Huang1 although he must have lived earlier than Huang1. He mentions Tibetan auspicious and inauspicious days combined with intercalation; the difference of new moon days between Tibetan and China; the different intercalation methods; Tibetan *rab byung* system (his understanding is based upon the equation of it with the Chinese *liushi jiazi* (六十甲子) system supported by *tiangan* (天干) and *dizhi* (地支)), etc. Of course, it is obvious that he has fragmental knowledge and information of Tibetan astrology / astronomy.

astronomical concepts and knowledge in Tibet.[370] In the Tibetan academy, it seems to have been significant only against the background of the *Mā yang rgya rtsis*. Although I investigated the *Mā yang rgya rtsis* in relation to the *Lixiang kaocheng*, one could ask this question again once more by looking into the relationship between the *Mā yang rgya rtsis* and the *Rgya rtsis chen mo*. My conclusion is that the *Rgya rtsis chen mo* shows no textual relationship to the *Mā yang rgya rtsis* text, at least given the differences in terminology.[371] The *Rgya rtsis chen mo* was compiled at the command of Elhe taifin Kangxi Emperor and instigated by his faith in Western astronomy. But it also means that the text as such has nothing to do with the Tibetan astronomy *per se*. The criticism in the preface of the *Tngri-yin udq-a* and the new knowledge found in the text itself aimed to introduce a new method calculating eclipses that were based upon Western / Chinese methods, but the Tibetans had absolutely no way to understand it.

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[370] For the question and my answer to this, see chapter 4.

[371] For my linguistic evidence, see below pp. 307-8. I think the terms listed are a bit technical. So, it would be better for them to be presented in chapter 4, not here. Again, I stress that Badzra (2003a), which argues for the continuation of the *Rgya rtsis chen mo* to the *Mā yang rgya rtsis*, is problematic. Another untenable groundless claim is Lobsang Yongdan (2015: 177): "the Jesuits' works that were translated into Tibetan and Mongolian or on the fact that Tibetans in Amdo reformed their calendar according to the system devised by Danish astronomer, Tycho Brahe (1546–1601)." As clarified in this section, it is true that the *Mā yang rgya rtsis* is based upon Tychonic astronomy. However, Tibetans did not know the nature of Tychonic astronomy. Most of all, such history that Tibetan astronomers created the *Mā yang rgya rtsis* on the basis of the knowledge on the *Rgya rtsis chen mo* does not exist. Simply, the *Mā yang rgya rtsis* is a system that translated the algorithm part for eclipse calculation included in the *Lixiang kaocheng*. See below note 654. Tibetan *skar rtsis* methods and approaches such as *rtsis 'phro* change, etc. were used to create the system. In other words, Tibetans absorbed the new methods on the basis of time-honored *skar rtsis* / *Kālacakra* system. There is no single evidence that they knew modern astronomy. Lobsang Yongdan (2015: 188-9) shows excessive attention to the issue of modernity in his attempt to place Tibet in the context of modern scientific history. Tibetan phrases and passages relevant to the history of the *Mā yang rgya rtsis* do not say so. Also see chapter 4.

In this chapter, I drew a broad picture without being restricted to a single text. I attempted to read the Tibetan approach to eclipse calculation by setting up the textual and non-textual "series." The gist is that the *skar rtsis* has been articulated, formulated, and modulated by the religious *Kālacakratantra* corpus, but it has not been separate from the non-textual "series." The method of calculating eclipses epitomizes the problem. In other words, showing the non-textual "series" involved in the eclipse calculation may be a way to elucidate the nature and features of *skar rtsis*. The solutions presented by the media for the non-textual "series" such as *myong byang*, *dris lan*, *man ngag*, Chinese and Mongolian texts, political support, etc. are essentially scattered, distracted, and fragmented. Using them, Tibetans tinkered with the revealed problems individually and sporadically for the purpose of "saving the phenomena." As a result, compared with the abundant information presented in the media, no significant impact on the *skar rtsi*s is seen. Astronomical observations, questions and discussions are combined with criticism, empirical knowledge evinces the emergence of challenging knowledge, and the transmission of new astronomical methods from China affects the understanding of the outer tradition in an inclusive way. We may be able to accumulate more information and data in the future, but at present I suggest that the criticism, impacts, and influences did not become a frame or system with fundamental and theoretical solutions for the Tibetan eclipse calculation. Instead, the *Kālacakra* is always there. The *skar rtsis* is justified by the *Kālacakra.*

At this point, it is natural to ask about the hermeneutical concepts *dgongs pa* (intention) and *mthun pa* (compatibility) that have been used in Tibetan astronomy. The former has been used within the frame of *skar rtsis*; the latter within the frame of the relationship between *skar rtsis* and *rgya rtsis*. The common denominator of the two is the *Kālacakra*. Firstly, *dgongs pa*. I have not yet found any textual phrases and sentences, but the following scenario may justify the *Kālacakra*: in the case of clear components in the textual and non-textual "series" against the "unclear" (*mngon med*) *Kālacakra,* the *dgongs pa* will be assumed. In the case of incoherence and conflicts among the components in the textual, non-textual "series," the *Kālacakra* will be reinforced. The absolute knowledge of the *Kālacakra* as well as its supreme religious authority is postulated.

Furthermore, I think *mthun pa* may be a hermeneutical concept for the *Mā yang rgya rtsis,* in the sense that it derives from a form of Chinese astronomy with a different origin from *Kālacakra*. "Being compatible to *skar rtsis*" (T. *skar rtsis dang mthun pa*) is seen *passim* in the *Mā yang rgya rtsis* corpus. It is not clear why Tibetans think that both are compatible. Of course, I think they surely know that the Chinese system is different from *skar rtsis*, even if Ser chen Zhabs drung (1861) is the only instance clearly stating "*mi mthun*" in the following way.

> *... 'di yi 'jig rten chags tshul sogs / 'ga' zhig dus kyi 'khor lo dang / mngon pa sogs dang mi mthun yang / rtsi na'i rang lugs rnam dag go / .* [372]
>
> Some things such as the way of the arising of the world, etc. of this (*Mā yang rgya rtsis*) do not agree with *Kālacakra* and *Abhidharma*, etc, but the Chinese tradition is impeccable.

[372] Ser chen Zhabs drung (1861: 3b). According to my reading, "*mi mthun*" is not often found to describe the relationship between *skar rtsis* and *rgya rtsis*.

The recognition of its difference from the *Kālacakra* and the *Abhidharma* is clear. However, Ser chen Zhabs drung has no theoretical background to articulate it. My point is that even if he says "*mi mthun*", his understanding is rooted in the *Kālacakra*. The *Kālacakra* for *skar rtsis* and the *Mā yang rgya rtsis* are assumed to be the common ground for the criteria he uses to judge the different systems. Therefore, the *mthun pa* is assumed also in the above passage, as is true for all the other *Mā yang rgya rtsis* texts I have perused.

Mthun pa is a concept or activity to inclusively understand or internalize unfamiliar outer concepts, ideas, thoughts, methods, theories, systems, etc. In that sense, it can be viewed in terms of the increase of new knowledge in *skar rtsis*, not in the increase of knowledge about Chinese astronomical methods themselves.[373] We may think

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[373] M. Foucault (1926-1984) may find the "*mthun pa*" interpretable in his philosophical scheme. To give some context, his academic concerns include knowledge and power. He focused on elaborating on knowledge in the archaeological stage and focused on power in the genealogical stage. Let me confine discussion to the topic of knowledge to explain the term "*mthun pa*." Foucault investigates archaeologically how knowledge constitutes human beings as the subject according to historical period. In his *The Archaeology of Knowledge* (*L'Archéologie du Savoir*), he presents the concept of the statement (énoncé) in order to elucidate how the discourses (discours), which are the object of his archaeological investigation, are formed. - The statement is the atom of the discourse; the discourse is a set of elements of the statement. - What makes his statement remarkable is that the discourse does not exist independently because it has meaning only if it is related to the other statements and is placed in certain discourses where certain rules dominate. Thus, his archaeological subject is the location of the subject as long as one occupies a certain location among discourses. And by way of his archaeological method, Foucault traces how the subject is formed historically. In his *Words and Things* (*Les Mots et les Choses*), archaeology is defined as the method investigating the historical formations and transformations of episteme (épistémè < G. ἐπιστήμη) as the regularity which is hidden but dominant and which underlies discourses and knowledge. The field of the statement, which is the formulation within which the statement appears, forms episteme, which is the transcendental structure and is the condition of possibility underlying the activities of discourses, including propositions and sentences. Peculiarly enough, he argues at this point that episteme is also historical a priori (l'a priori historique) in that it is a regularity that unconsciously dominates certain discourses and knowledge in a certain historical period and in that, it undergoes historical changes itself. According to him, the historical a priori does not exist before history is reified, but is formed through the long-term process of production of knowledge. Therefore, it works as the rule to the production of knowledge and is simultaneously established by the rule. The episteme of resemblance (ressemblance) *is dominant* during the Renaissance, representation (représentation) during the Classical Period, and the

about the following issues: the transformation of what had been received or different understanding of what had been received. I think that Tibetans transformed some Chinese elements according to *skar rtsis*.[374] Generally, Tibetan self-understanding of *skar rtsis*, not Chinese methods, has expanded. In the same vein, one may ask whether or to what degree the phenomena of eclipse was differently understood after the introduction of M*ā yang rgya rtsis*. The anwer may vary depending on which point we focus, but in terms of the expansion of modern scientific knowledge, I do not think Tibetans disengaged from the *Kālacakra* / *skar rtsis* and began to see a different world.[375] All in all, *mthun pa* may mean the internalization of other traditions without a clear sense of the difference between the self and others in the context of the *Mā yang rgya rtsis*.

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analytic of finitude (l'analytique de la finitude) during the modern period. All in all, through the episteme, which is fundamentally human thoughts and experiences distributed in the space of knowledge and the immanent structure in the historical process, he deals with formations and transformations of discourses. As a result, he reveals the basis of thoughts of certain periods by excavating the possible conditions enabling cognition in real human history. Going back to the Tibetan concept, "*mthun pa*," research into the later period *rgya rtsis* reveals that the comparison of day- (*tshes grangs*), year-reckoning (*lo mgo*), intercalation (*zla bshol*, *sgang* method), etc. are the main concerns of Tibetans about the Chinese tradition. The components may have been thought to be the ground of *mthun pa,* because their parallels are found in *skar rtsis*. — I have not found any text pinpointing the rationale of the "*mthun pa*" yet. — Tibetan astronomers have captured the resemblance between the Chinese astronomical elements and Tibetan elements, and *skar rtsis*-ized the Chinese elements. The episteme of resemblance may fundamentally regulate the way of thinking and approach involved in the adoption of outer tradition.

[374] See chapter 4.

[375] See chapter 4.

At this point, let me attempt the fusion of Gadamer's "commonality"[376] and the Galison's linguistics-based concept, "creolization."[377] Tibetans' astronomical level and concept and methodology remain in their one and the only dominant system, i.e. *Kālacakra*. Gadamer may say that Tibetan astronomy is bound to the "commonality" of the *Kālacakra*. In terms of shared knowledge in a community or society, Amdo, Khams, and Lhasa before 20th century were different from Beijing where western Jesuit astronomy was dominant. The Lama in Beijing, founder of the tradition later known as the *Mā yang rgya rtsis*, must have witnessed the different scientific climate and maturity.

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[376] Gadamer's (1900-2002) concept, 'the fusion of horizons' (Horizontverschmelzung) of two or more different knowledge systems or traditions, may be useful to appraise the Tibetan adoption of the Chinese tradition. Gadamer (1960: 277) [= (2004: 293-4)] explains Martin Heidegger's (1889-1976) ontological hermeneutics in the sense that human understanding is grounded in "commonality" and "tradition." — It is related to his criticism of Friedrich Schleiermacher (1768-1834) without considering "concretion of historical consciousness." — : "Heidegger's description and existential grounding of the hermeneutic circle, by contrast, constitute a decisive turning point. ... The circle, then, is not formal in nature. It is neither subjective nor objective, but describes understanding as the interplay of the movement of tradition and the movement of the interpreter. The anticipation of meaning that governs our understanding of a text is not an act of subjectivity, but proceeds from the commonality that binds us to the tradition. But this commonality is constantly being formed in our relation to tradition. Tradition is not simply a permanent precondition; rather, we produce it ourselves inasmuch as we understand, participate in the evolution of tradition, and hence further determine it ourselves. Thus the circle of understanding is not a "methodological" circle, but describes an element of the ontological structure of understanding."

[377] Galison's term, "trading zone," was devised to explain the communication and interactions among different groups of scientists. He presented the following examples of the "trading zone": during World War II, physicists and engineers worked jointly to develop radar at MIT's Radiation Laboratory (Rad Lab), and physicists and mathematicians co-developed the Monte Carlo Simulation. The term, challenging the "incommensurability" raised by Thomas Kuhn (1922-1996), concerns linguistic pidginization and creolization. Galison (1997: 770): The pidgin focuses on "exchange function". About the creole language, Galison (1997: 783): "cultures in interaction frequently establish contact languages, systems of discourse that can vary from the most function-specific jargons, through semispecific pidgins, to full-fledged creoles rich enough to support activities as complex as poetry and metalinguistic reflection." Since he focuses on how experiments, instruments etc, function in the communication of different sciences, his theory may not be applicable to east Asian science, which would inevitably involve a possible argument substantiating the understanding of the heterogeneous Western sciences through the import/ adoption of them.

Amdo, in which the Chinese calendar was studied[378] may be better than Lhasa in terms of the condition for "the creole language", but Lhasa and Khams were too far away from the *han* Chinese cultural and scientific areas.[379] My point is that without the "commonality" of background knowledge and social scientific context, "the fusion of the horizons" might have no choice but to work inclusively, without evolving to "a creole language." In the Tibetan context, the *Mā yang rgya rtsis* terminology, coined possibly by the Beijing lama, could not not go through "the creolization" in the Tibetan areas. Because the *Kālacakra* was a "commonality" and "tradition," the new calculational method could not be understood. The method of looking up in the tables and using the algorithm in the *Mā yang rgya rtsis* does not advance the Tibetan astronomy further.

I defined *dgongs pa* within the *skar rtsis* tradition, and *mthun pa* from the relationship between *skar rtsis* and the *Mā yang rgya rtsis*. The two hermeneutical concepts have the common ground of *Kālacakra,* which is the only reference system in Tibet. Most of all, as far as the *Mā yang rgya rtsis* is concerned, it is difficult to say whether an essential increase to or change to the frame of the *Kālacakra* has been attempted or achieved by its assimilation into the new method. Simply, the Tibetan way of understanding and assimilating the Chinese eclipse calculation method in the *Mā yang rgya rtsis* is to find

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378 The Kye rdor grwa tshang at Bla brang bkra shis 'khyil established in 1877 is one of the places where the Qing Chinese calendar was studied.

379 It also explains the slow transmission of the *Mā yang rgya rtsis* from Beijing thru Amdo to Khams and Lhasa. During Mkhyen rab nor bu's time, it was transmitted to Lhasa. For more information, see Yum pa (2008: 269-70). In the case of Khams, I guess that Mi pham (2012a), which was assumed to have been written immediately before his death in 1912, seems to be the first text that evidences a kind of transmission.

possible rationale, centered upon the *skar rtsis* / *Kālacakra*. It follows then that the *Mā yang rgya rtsis*, which is based upon different theory and mathematics, appears compatible (*mthun pa*) with their own tradition. *Skar rtsis* expanded the boundary in the course of making sense of the *Mā yang rgya rtsis*, and ultimately, the *Kālacakra* astronomy has been solidified.

Lastly, I raise again the essential issue, i.e. the paradox in terms of "sensation" in a Deleuzian sense. The textual (religious) origin/ non-textual (religious or non-religious or both) "series" function together compatibly. The two are not antithetical. No conflicting relationship is posited. It is a paradox. Deleuze says, "The force of paradoxes is that they are not contradictory; they rather allow us to be present at the genesis of the contradiction." [380] The "series" converge towards and disperse from "paradoxical element" which effects the three syntheses: "the connective synthesis, which bears upon the construction of a single series; the conjunctive series, as a method of constructing convergent series; and the disjunctive series, which distributes the divergent series."[381] The "connective synthesis" integrates elements constituting a "series", the "disjunctive synthesis" ramifies and differentiates to create a divergent "series", and the "conjunctive synthesis" is where different "series" converge toward a point, i.e. "paradoxical

[380] Deleuze (1973: 102) [= Lester and Stivale tr. (1990: 74)].

[381] Deleuze (1973: 238) [= Lester and Stivale tr. (1990: 174)].

element"/ "aleatory point."[382] The syntheses are applicable to the two "series", textual / non-textual, classified by this writer to explain the approaches to eclipse calculation in Tibet: The "connective synthesis" within the textual "series" is based upon the *Kālacakra* / Buddhist texts. With that, the *skar rtsis* astronomy is constituted. And the "disjunctive synthesis" is the dispersion and the expansion of communication in an inclusive way within the textual "series" and within the non-textual "series," respectively and mutually. The "conjunctive synthesis" is produced by the common denominater of the previous two "syntheses." Two resonating "series" converge towards "the aleatory point," i.e. the *Kālacakra* astronomy with more concreteness and more newness. Deleuze says, "As for the conjunctive synthesis, it tends also toward being subordinated to the synthesis of connection, since it organizes the converging series over which it bears as it prolongs them under a condition of continuity."[383] By the syntheses, he intends that the "structure" ("champ transcendental"/ "transcendental field") which is composed of such elements as "aleatory point", plural "series," etc. are inevitable for the "devenir" (becoming/ genesis).[384] Likewise, the *Kālacakra* astronomy embodied in *skar rtsis* is in the

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[382] Bogue (1989: 76): "The aleatory point [= paradoxical element] produces structures by effecting three syntheses: a connective synthesis that establishes a single series; a conjunctive synthesis that sets two series in resonance; and a disjunctive synthesis that causes series to branch out in divergent directions. ... The connective synthesis establishes differences between terms within a series, the conjunctive synthesis creates differences between the differences of the two series, and the disjunctive synthesis affirms difference by differentiating ifself into two divergent series. Ultimately, the paradoxical element sets all series in resonance and itself traverses all series, ... "

[383] Deleuze (1973: 239) [= Lester and Stivale tr. (1990: 175)].

[384] Deleuze (1973: 88-90) [= Lester and Stivale (1990: 64-5)].

middle of a journey of “devenir.” The generation of meaning in the Tibetan *skar rtsis* eclipse calculation is in development by the approach and method realized by the textual and non-textual “series.” And the seemingly contradictory values and ideas and theories seen in multi “series” all make sense and are affirmed as sources of knowledge. The incessant formation by syntheses is paradox in the Deleuzian sense. The *skar rtsis* clarifies the *Kālacakra* with reality, while making sense of the textual and non-textual “series” ; the acquired reality unites the authority of the *Kālacakra* with esoteric abstraction.

CHAPTER FOUR

METHODS FOR ACCURACY IN ECLIPSE PREDICTION

INTRODUCTION

Chapter 4 represents the continuation of the ideas presented in chapter 3. The approaches mentioned in chapter 3 are tied to real mathematical considerations in chapter 4. In other words, it is possible that observation, empirical knowledge, discussion/ debates/ criticism, etc., influenced mathematical considerations, including *nur ster* applied to the longitude of the sun and moon, *rtsis 'phro* / *stong chen 'das lo* corrections, which will be mentioned in this chapter.[385] Regarding the issue of different traditions referred to in chapter 3, I will briefly mention mathematics of the *Mā yang rgya rtsis* and the *Rgya rtsis chen mo* from the perspective of their use for the increase of the accuracy of eclipse calculations. Both are based upon different mathematics from *skar rtsis* mathematics, but are understood within the *skar rtsis* mathematical framework supported by the *Kālacakra*. From that point of view, parallax and geographical knowledge based upon Western and Chinese trigonometry will be mentioned, in

[385] This argument should be demonstrated through textual evidence. I have focused on this concept and presented related proofs in this chapter. However, more evidence should be identified to substantiate it.

conjunction with the arithmetic approach of the *skar rtsis*. From a macro perspective, the methodological and mathematical unfolding of *skar rtsis* made by adopting “textual” and “non-texutal” sources has been conditioned by the *Kālacakra*. Whatever mathematical methods were taken, they were restricted by the *Kālacakra* in the case of *skar rtsis* or were interpreted in conformity with the the *Kālacakra* in the case of *rgya rtsis*. The direction of evolution of the *skar rtsis* approach and mathematical methods has been determined solely by the *Kālacakra.* This chapter validates the argument.

1. *SKAR RTSIS*

1.1. BASIC KNOWLEDGE USED IN CALCULATIONS

Firstly, the *bhūtasaṃkhyā* system in Indian astronomy[386], which uses some words to represent numbers, must be understood.[387] The *Dag yig mkhas pa'i byung gnas* (M. *Merged γarqu-yin oron neretü toγtaγaγsan dagyig*)[388] nicely provides us with the following list of synonyms for each number.[389]

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[386] See Neugebauer and Pingree (1970: 185): The *bhūtasaṃkhyā* system in Varāhamihira's (505-587) *Pañcasiddhāntikā* is given.

[387] The information is commonplace. For example, Petri (1966: 22-6), Kilty (2004: 605-9), etc. It is essentially Indic.

[388] For the introduction of the *Merged γarqu-yin oron*, see Heissig (1959: 159-61), Seyfort Ruegg (1974: 245-6), Taube (1978), Dharmatāla as translated in Klafkowski (1987: 391-5), Sárközi (2010: 101-9), Kanaoka (1986:

Table 9.

	Synonyms (T.(M.))
1	*ri bong can (taulai-tu), zla ba (sara), gzugs (üngge), 'od dkar can (čaγan gerel-tü), bse ru (kers-ün eber).*
2	*'khrig pa (quričaqui), bgrod pa (yabudal), thabs shes (arγ-a bilig), mtshe ma (iker-e), lag pa (γar), mig (nidün), zung (qous).*
3	*'jig rten (yirtinčü), tsha ba (qalaγun), rtse mo (üǰügür), me (γal), yon tan (erdem), srid pa (sansar).*
4	*rgya mtsho (dalai), chu bo (müren), rig byed (uqaγuluγči), bdud (simnus), ste ba (sic.* read *sde pa) (aimaγ), chu gter (usun-u sang).*
5	*'dod yon (küsel-ün erdem), nyer spyod (čiqula edlegči), dbang bo (erketen), mda' (sumun), phung po (čoγča), 'byung ba (maqabud).*
6	*ro (amta), dus (čaγ), mtshams (ǰabsar), bro ba (amsaqu), rgyan (čimeg), bzang po (sain).*
7	*rin chen (erdeni), sa 'dzin (γaǰar bariγči), thub pa (čidaγči), ri bo (aγula), drang srong (arsi), gza' (γaraγ), rta (mori).*
8	*bkra shis (ölǰei quduγ), lha (tngri), klu (gluus), nor (ed), gdengs can (erbeger-tü), nor lha (ed-ün tngri), lto 'gro (kebeli-ber yabuγči).*
9	*rtsa (ündüsün), srin po (mangγus), bu ga (üge), gter (sang).*
10	*khro bo (kiling-tü), 'byor pa (učaral), phyogs (ǰüg), 'jug pa (oruqui), stobs (küčün), sor mo (quruγun).*
11	*bde byed (amuluγči), bde 'byung (amuγulang qaraγči), dbang phyug (erketü), drag po (doγsin), byed pa (üiledügči).*
12	*nyi ma (naran), rten 'brel (sitün barilduγči), khyim (ger).*
13	*'dod pa (küsel), lus med (bey-e ügei), myos byed (γalǰaγuraγuluγči), sna tshogs (eldeb ǰüil), gdugs rim (sigür-ün dabqurliγ).*
14	*srid (sansar), yid (sedkil), ma nu (manu), shed bu (sedkil-ün kübegün).*
15	*tshes (sin-e), nyin zhag (edür-ün qonuγ).*
16	*mi bdag (kümün-ü eǰen), rgyal po (qaγan), cha shas (qubi).*
18	*nyes pa (erekü), skyon (gem), khams (iǰaγur).*

164-8), Kanaoka (1987: 195-230), etc.. It was completed by Lcang skya III and others in 1742 (Abkai wehiyehe Qianlong 7th year). See Lcang skya III et al. (1982: 21), Lcang skya III et al. (2002: 1427-8). This work basically represents a *dag yig* text, but is closer to *mngon brjod* (S. *abhidhāna*) as far as the section of astronomy (T. *bzo ba rig pa'i skor* / M. *uralaqu uqaγan–u γoul*) is concerned. At least two *Kālacakra* specialists participated in the compilation of this section. See Lcang skya III et al. (1982: 20), Lcang skya III et al. (2002: 1422-4): "A proponent of *bzo rig*, Se chen Rab 'byams pa Blo bzang sangs rgyas (M. Lobsangsanǰai), who came from Dbus gtsang in Tibet ... A *Kālacakra* proponent at Sgo mang dam chos gling Amdo, Chos rje Rab 'byams pa Blo bzang rgyal mtshan Blo bzang rgyal mtshan (M. Lobsangǰalzan)." (*töbed buizang-ača iregsen ǰiruqai-yin uqaγan-i ügülegči sečen rabǰamba lobsangsanǰai, ... amduu-yin γuumang tamčoiling keid-ün doingqurba bandida čorǰi rabǰamba lobsangǰalzan, ... / bod dbus gtsang nas phebs pa'i bzo rig smra ba se chen rab 'byams pa blo bzang sangs rgyas ... A mdo sgo mang dam chos gling gi dus 'khor ba paṇḍi ta chos rje rab 'byams pa blo bzang rgyal mtshan ... .).* However, given the colophon, some other scholars in the colophon may have background knowledge on astronomy, aside from these two.

[389] Lcang skya III et al. (1982: 58-9). Lcang skya III et al. (2002: 1206-11). The references present a problematic situation. *Srid pa* means 3 or 14. Note that it is used as 14 in most cases and it is rarely used as 3. A similar problem is also seen in Phyag mdzod reproduced in Huang and Chen (1987: 7).

Table 9 (continued)

24	*rgyal ba (ilaγuγsan), yul (oron).*
25	*de nyid (tere-kü činar).*
27	*'khor lo (kürdün), skar ma (odun).*
32	*so (sidün), gnyis skyes (qoyar ta törügči).*
0	*stong pa (qoγusun), nam mkha' (oγtarγui).*

It is important to note that numbers are read in a reverse order. For example, *me* (3) *mkha'* (0) *rgya mtsho* (4) is 403, not 304. The technical terms of the four fundamental arithmetic operations are as follows.[390] The operations were developed by *sa gzhong*.[391]

Table 10.

	T.	M.
add	*bsre ba*	*qolidqu*
	ster ba	*ögkü*
	phul ba	*tülkikü*
	sbyin pa	*üglige*
	'bul pa	*ürgükü*
	bsnan pa	*nemekü*
	bsnon pa	*nemeri*
	nor du 'gyur ba	*ed bolγaqu*
	ldan pa	*tegüsgekü*
subtract	*'phri ba*	*qasuqu*
	sbyang ba	*arilγaqu*
	'phrog pa	*buliyaqu*
	zhu ba	*simedgekü*
	'phral ba	*qaγačaγulqu*
	dor ba	*nuγurqu*
	'brid pa	*bayuraγulqu*
	dman pa	*doruitaγulqu*
	bu lon 'gyur ba	*üri bolγaqu*

390 Lcang skya III et al. (1982: 59-60), Lcang skya III et al. (2002: 1212-3).

391 For further information on the calculations with an Tibetan sand abacus (T. *sa gzhong*), see Schuh (1970) which describes *Mkhas dbang 'dus byung pa'i rde'u'i rtsis gzhung sarga brgyad la dag ther byas pa rab sbyang gser gyi me long*, the treatise of the *rde'u rtsis* was written by 'Dus byung pa (aka Ānanda) during the period of Dalai lama V (1617-1682). Schuh indicates that the calculations made with an abacus were for the conversion of units during taxes calculations after the harvest.

Table 10 (continued)

	dben pa	*alaydaqu*
multiply	*bsgyur ba*	*qubilyaqu*
	bsnun pa	*teledkü*
	sbel ba	*arbidqaqu*
	bsgres pa	*körbegülkü*
	gsil ba	*čočalaqu*
divide	*bgo ba*	*qubiyaqu*
	phye ba	*salyaqu*
	bsal ba	*ilyaqu*
	bcad pa	*tasulqu*

The following phrases are often seen in *rtsis* literature:[392]

Table 11.

	T.	M.
erase	*phyis pa*	*arčiqu*
	dbyi ba	*ilikü*
	bsubs pa	*balilqu*
obtain	*rnyed pa*	*olǰa*
	thob pa	*oluysan*
	nor	*ed*

The units of time and space must also be understood. Such units as *chu tshod*, *chu srang*, *dbugs,* and *cha shas* are used for temporal and spatial divisions. 1 day equals 60 *chu tshod* (S. *nāḍī, ghaṭī*, *ghaṭikā*, *daṇḍa*), 1 *chu tshod* equals 60 *chu srang* (S. *pāṇipala, liptā, vināḍī*), 1 *chu srang* equals 6 *dbugs* (S. *śvāsa, prāṇa).* (one day equals 21600 *dbugs* (= 60 × 60 × 6)).[393] The ecliptic is divided into 27 *rgyu skar*[394] counted from *tha skar* (S. *Aśvinī*). 1 *rgyu*

[392] Lcang skya III et al. (1982: 59-60), Lcang skya III et al. (2002: 1213).

[393] See Petri (1966: 30-3), Schuh (1973a: 64-7), Henning (2007: 12-5). For the Mongolian synonyms, see Lcang skya III et al. (1982: passim): *chu tshod* (M. *möče*), *chu srang* (M. *čenglegür*), *dbugs* (M. *amisqul*), *cha shas* (M. *qubi*). About *chu tshod*, Ishihama and Fukuda (1989: 384): S. *ghaṭikā*, *nāḍī*; T. *chu tshod* [ML] *usun-u kemjig-e* [MT] *usun-u kemjig-e*. Sárközi and Szerb (1995: 542) renders it as "clepsydra." It is related to the ancient method of measurement by water clock, but "clepsydra" is not a proper rendering.

[394] The list of 27 lunar mansions (S. *nakṣatra* / T. *rgyu skar* / M. *odun*) in Lcang skya III et al. (1982: 49), Lcang skya III et al. (2002: 1166-70), and Ishihama and Fukuda (1989: 162-3) is as follows. For the list in Sanskrit, see Pingree (1978: 535). For the list in Tibetan, see Schuh (1973a: 147-8), Henning (2007: 356-7), Kilty (2004: 600-1). For the list in Mongolian, see Sárközi and Szerb (1995: 235-7), Baumann (2008: 99-114). As seen below, some variations of phonetical complexity are seen in the case of the Sanskrit transliterations in Mongolian.

Lcang skya III et al. (2002).		Ishihama and Fukuda (1989)
T.	M. (S.)	
0 *tha skar*	*ašuwani* (< S. *aśvinī*)	[ML] *asuvani beriy-e* [MT] *asuvani*
1 *bra nye*	*barani* (< S. *bharaṇī*)	[ML] *barni tulγ-a* [MT] *brani*
2 *smin drug*	*kirdig* (< S. *kṛttikā*)	[ML] *kirtik mecid* [MT] *kirtik*
3 *snar ma*	*rügini* (< S. *rohiṇī*)	[ML] *rokini sor* [MT] *rowakini*
4 *mgo*	*mergesir* (< S. *mṛgāśiras*)	[ML] *margasiri terigün* [MT] *margasar*
5 *lag*	*ardir* (< S. *ārdrā*)	[ML] *ardir γar* [MT] *ardir*
6 *nabs so*	*burniwasu* (< S. *punarvasu*)	[ML] *bunarvasu eki ilaγuγsan* [MT] *buranisu*
7 *rgyal*	*bus* / *büs* (< S. *puṣya*)	[ML] *bus adaγ ilaγuγsan* [MT] *buya*
8 *skag*	*aslis* (< S. *aśleṣā*)	[ML] *askes enggeske* [MT] *aslis*
9 *mchu*	*mig* (< S. *maghā*)	[ML] *mag qosiγun* [MT] *mag*
10 *gre*	*burwabalgüni* (< S. *pūrvaphālgunī*)	[ML] *burvabalguni baγ-a süke* [MT] *burinabalguni*
11 *dbo*	*udarabalgüni* (< S. *uttaraphālgunī*)	[ML] *utirabalguni kegürjigene* [MT] *utirabalguni*
12 *me bzhi*	*qasda* (< S. *hasta*)	[ML] *qasta qarcaγai* [MT] *qasta*
13 *nag pa*	*zidir-a* (< S. *citrā*)	[ML] *tsitar qong keriy-e* [MT] *caitir*
14 *sa ri*	*suwadi* (< S. *svāti*)	[ML] *svati eki oγtarγui* [MT] *suvati*
15 *sa ga*	*šušiγ* / *šošiγ* (< S. *viśākhā*)	[ML] *śusak adaγ oγtarγui* [MT] *śusag*
16 *lha mtshams*	*anurad* (< S. *anurādhā*)	[ML] *anurad jabsar* [MT] *anurad*
17 *snron*	*čisda* (< S. *jyeṣṭhā*)	[ML] *jist sitaγamal* [MT] *jista*
18 *snrubs*	*mol* / *mul* (< S. *mūla*)	[ML] *mul tosun* [MT] *mul*
19 *chu stod*	*burwasad* (< S. *pūrvāṣāḍhā*)	[ML] *burvasad eki usun* [MT] *burinsad*
20 *chu smad*	*utarasad* (< S. *uttarāṣāḍhā*)	[ML] *utirasad adaγ usun* [MT] *utirasad*
21 *gro bzhin*	*sirawan* (< S. *śravaṇa*)	[ML] *siravan buγudai cilan* [MT] *siratan*
		S. *abhijit* T. *byi bzhin* [ML] *abiji quluγun-a* (sic. read *quluγan-a*) *cilan* [MT] *abidsi*
22 *mon dre* (*gre*)	*danisda* (< S. *dhaniṣṭhā*)	S. *śatabhiṣā* T. *mon gre* [ML] *satabis sim* [MT] *satabis*
23 *mon gru*	*sadibis* (< S. *śatabhiṣaj*)	S. *dhaniṣṭhā* T. *mon gru* [ML] *danis sibaγun u segül* [MT] *danista*. Ishihama & Fukuda confuse *mon gre* with *mon gru*
24 *khrums stod*	*burwabadrabud* (< S. *pūrvabhādrapadā*)	[ML] *burvabadirabad eki quduγ* [MT] *burvabadi rabad*
25 *khrums smad*	*udarabadrabad* (< S. *uttarabhādrapadā*)	[ML] *utirabadirbad adaγ quduγ* [MT] *utirabadirabad*
26 *nam gru*	*riwadi* (< S. *revatī*)	[ML] *revati aγun ongγuca* [MT] *rivati*

The synonyms of the 28 lunar mansions (T. *rgyu skar nyer brgyad* / M. *qorin naiman odun*) are given in Lcang skya III et al. (1982: 56-7) and Lcang skya III et al. (2002: 1196-202). About the *byi bzhin* which is not used in the 27 *rgyu skar* system, Lcang skya III et al. (2002: 1196-7) explains: "Because the longitude of the two, *gro bzhin* and *byi bzhin*, are the same, 27 *rgyu skar* ... ." (*gro bzhin byi bzhin gnyis longs spyod gcig pas* (M. *nigen edlel-*

tü-yin tula) *rgyu skar nyer bdun* (M. *qorin doluɣan bütügči* (?) *odun*) ... .). The following table is based upon Lcang skya III et al. (2002).

T. (M.)	T.	M.
tha skar (*ašuwani*)	*gsal ba'i bu mo*	*todurqai-yin ökin*
	rta ldan ma	*morin-tu eke*
	dbyu gu	*sidim*
bra nye (*barani*)	*gshin rje ma*	*erlig eke*
	sgeg mo'o	*üǰügürgegči eke*
smin drug (*kirdig*)	*mang po karti*	*olan kirdi*
	ma drug bu	*ǰirɣuɣan eke-yin kübegün*
snar ma (*ruwagini*)	*bi rdzi*	*birzi*
	dal ba'i lha ldan ma	*tülügen tngri-tu eke*
	skye dgu'i bdag po	*kedün törülkiten-ü eǰen*
mgo (*mergesir*)	*smal po*	*smalbuwa*
	mgo skyes	*toluɣai-ača törügsen*
	ri dwags mgo	*gürügesün toluɣai-tu*
	zla skyes	*sara-ača törügsen*
lag (*ardar*)	*nag mo*	*qar-a eke*
	drag mo	*doɣsin eke*
	drag shul ma	*qataɣu küčütü eke*
	dmag dpon dgra	*čerig-ün noyan-u daisun*
nabs so (*burniwasau*)	*sbyin mo'i lha mo*	*ögligeči eke-yin ökin tngri*
	shu kra ma	*šugr-a-tu eke*
	rgyal stod	*büs-ün ekin*
rgyal (*büs*)	*bla ma'i lha ldan*	*suru kürü-tü*
	sbyor ldan ma	*nairaltu eke*
	grub pa	*bütügsen*
	tshim byed	*qangɣaɣči*
skag (*aslis*)	*gdengs can lha mo*	*erbeger-tü ökin tngri*
	wa	*ünege*
mchu (*meg*)	*pha mes lha skyes*	*ečige ebüge tngri-eče törügsen*
	snyan ngag mkhan	*ǰokistu ayalɣuči*
	rta chen	*yeke morin*
gre (*burwabalgüni*)	*rta chung*	*üčüken morin*
	'tsho ba	*teǰigel-tü*
	skyes pa	*törülki-tü*
dbo (*udarabalgüni*)	*phyi mo*	*uɣ-un eke*
	nyi ma'i lha ldan	*naran-u tngri-tü*
	khra	*qarčaɣai*
	sbo	*kökengki*
me bzhi (*qasda*)	*rig byed*	*vid šasdir*
	bya ma 'don	*čaidar ɣarɣaɣči*
nag pa (*čaidar*)	*bya'u*	*sibaɣuqai*
	brgyad ldan ma	*naiman tegülder eke*
	zla ba'i thog ma	*saran-u eng terigün*

sa ri (*sudi*)	*rlung gi lta mo*	*kei-yin ökin tngri*
	rlung gi dbang phyug	*kei-yin erketü*
	swā sti	*suwadi*
sa ga (*šošiγ*)	*bi shā khā*	*višaka*
	rgyud ldna ma	*ündüsün tegülder eke*
	dbang po'i lha ldan	*erketü-yin tngri-tü*
lha mtshams (*anurad*)	*lag sor*	*γar-un quruγu*
	a nu rādhā	*anurad*
	mdza'i lha	*amaraγ-un tngri*
snron (*čisda*)	*lde'u*	*ldeyoo*
	gang bu	*qongγurčaγ*
	lha dbang ldan	*tngri-yin erke tegülder*
	rdzye ṣṭa	*čisda*
snrubs (*mul / mol*)	*māu la*	*mo(u)la*
	gru sog ma	*dalun-u ünčüg-tü eke*
	rtsa ba	*ündüsün*
chu stod (*burwasad*)	*bre*	*šing*
	bu rbāṣaḍha	*burwasad*
	chu lha ldan	*usun tngri-tü*
chu smad (*utarasad*)	*u tta ra ḍha*	*utarasad*
	phul	*nigen bitegü* — I don't know how this one is equivalent to *phul.* —
	sna tshogs lha ldan	*eldeb tngri-tü*
gro bzhin (*šarawan*)	*shra wa ṇa*	*šrawana*
	'grog byed	*boliγči*
	bon po	*bombuwa*
byi bzhin (*abizi*)	no other names.	
mon dre (*danisda*)	*nam mthong*	*söni üǰegči*
	thob ldan ma	*olǰa-tu eke*
	dha ni ṣṭa	*danisda*
mon gru (*sadibis*)	*chu'i lha mo*	*usun-u ökin tngri*
	sgrog	*čidar*
	nam mthong 'og	*douratu söni üǰegči*
	sha ta bhiṣa	*sadibis*
khrums stod (*burwabadrabad*)	*bya mchu*	*sibaγun-u qusiγun*
	ra yi lha mo	*imaγan-u ökin tngri*
	gnas ma	*oron-u eke*
khrums smad (*udarabadrabad*)	*utta ra bha dra pā*	*udarabadrabad*
	ze'u	*tuγurčaγ-tu*
	sbrul	*moγai*
	'chings	*büse-tü*
nam gru/ riwadi	*bso ba'i lha mo*	*edegegči ökin tngri*
	re ba ti	*riwadi*
	shes pa	*medegči*
	rgyas byed	*delgeregülügči*

skar $= 60^{q}$ (*yul gyi chu tshod*) $=$ 4 *rkang pa*-s $\times$ 15 *yul gyi chu tshod*. Thus, 1 ecliptic $=$ $60^{q} \times 27 = 1620^{q}$. Therefore, $1620^{q} \div 360^{\circ} = 4.5^{q} / 1^{\circ}$, i.e. $4^{q}30'$ equals 1° modern unit, or 1^{q} $= \frac{2}{9}^{\circ}$. Because the same units are used for time (T. *dus*) and space (T. *yul*), *dus kyi chu tshod* and *yul gyi chu tshod* are differentiated. For example, 37^{q} in $3^{z}37^{q}43'2''140'''$ is *dus kyi chu tshod* (temporal *chu tshod*). The first place is *gza'*. Meanwhile, 37^{q} in $3^{k}37^{q}43'2''140'''$ is *yul gyi chu tshod* (spatial *chu tshod*). The first place is *rgyu skar*.[395]

The three different types of day-reckoning (*zhag gsum rnam dbye*) are important. *Nyin zhag* (civil days reckoned from sunrise to sunrise / dawn to dawn; S. *sāvana dina*), *khyim zhag* (zodiacal day; S. *saura dina*), which are $\frac{1}{30}$ of the interval between zodiacs[396],

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The Sanskrit transliterations are not organized or uniformed in Lcang skya III et al. (2002). It partly shows some different transliterations for a single Sanskrit term. The same is applied for Lcang skya III et al. (1982). Their original xylographs must be checked.

[395] Two radice for the notation of the astronomical unit exist; one is for *dus* (temporal unit): *gza'*, *dus kyi chu tshod*, *chu srang*, *dbugs*, *chas shas* are used for *gza' dhru*, *gza' bar*, and *gza' dag*, etc. The other is for *yul* (spatial unit): *rgyu skar, yul gyi chu tshod*, *chu srang*, *dbugs*, and *cha shas* are used for *nyi dhru*, *nyi bar*, *nyi dag*, and *sgra gcan*, etc. Different notations have been tried by modern scholars: Schuh (1973a) uses a sexagesimal position system. For example, in this case, [3,37,43,2,140]/(7,60,60,6,707) is a temporal unit and [3,37,43,2,140]/(27,60,60,6,707) is a spatial unit. Henning (2007) follows the example of Neugebauer: 3;37,43,2,140 (7/60/60/6/707), 3;37,43,2,140 (27/60/60/6/707). Huang and Chen's (1987) notation method is demonstrated by $3^{z}37^{q}43'2''140'''$ ($^{z} =$ *gza'*, $^{q} =$ *chu tshod*, $' =$ *chu srang*, $'' =$ *dbugs*, $''' =$ *cha shas*, ...); $3^{k}37^{q}43'2''140'''$ ($^{k} =$ *rgyu skar*, $^{q} =$ *chu tshod*, $' =$ *chu srang*, $'' =$ *dbugs*, $''' =$ *cha shas*, ...). This method may be used to simply discriminate among the units. In the case of *cha shas*, its *dkyil 'khor* is not always 707. See Bsam 'grub rgya mtsho (2011: 28) [= *Bod rgya tshig mdzod chen mo* (2000: 776)]. In this work, I will follow Huang's method, as shown in Huang and Chen (1987).

[396] The list of the 12 zodiacs is as follows.

Lcang skya III et al. (2002: 1183-4)	
T. (S. / Western)	M.
0 *lug* (*Meṣa* / Aries)	*qonin*
1 *glang* (*Vṛṣabha* / Taurus)	*üker*
2 *'khrig pa* (*Mithuna* / Gemini)	*qamtudγaqu*

and *tshes zhag* (lunar days, S. *tithi*), which are $\frac{1}{30}$ of the mean synodic month, with has various lengths.[397] The *tshes zhag* is related to bright fortnights (T. *yar ngo. dkar phyogs.* S. *śuklapakṣa*) and dark fortnights (T. *mar ngo. dmar phyogs. nag phyogs.* S. *kṛṣṇapakṣa*), i.e. 1/15 of the waxing and waning moon periods, respectively. The mean motion of the Sun and the Moon in the *grub rtsis* system is calculated using the following formulae: length of a *khyim zhag* $=$ length of a *tshes zhag* $\times\,(1+\frac{2}{65})$.[398] Length of a *tshes zhag* $=$ length of a

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3 *karka ṭa* (*Karkaṭa* / Cancer)	*menekei* (?)***
4 *seng ge* (*Siṃha* / Leo)	*arslan*
5 *bu mo* (*Kanyā* / Virgo)	*ökin*
6 *srang* (*Tulā* / Libra)	*čenglegür*
7 *sdig pa* (*Vṛścika* / Scorpio)	*kilinče*
8 *gzhu* (*Dhanus* / Sagittarius)	*numun*
9 *chu srin* (*Makara* / Capricorn)	*madar* (?)
10 *bum pa* (*Kumbha* / Aquarius)	*qomq-a*
11 *nya* (*Mīna* / Pisces)	*ǰiγasun*

*** *gergete* is given in Lcang skya III et al. (2002: 1167). Different Mongolian transliterations for a single Sanskrit term are seen. The same is applied to Lcang skya III et al. (1982: 49, 53). Their original xylographs must be checked. In conjunction with the linguistic complexity in Mongolian transliterations for the zodiacs, see Shōgaito (1990: 163-4) based upon the Mongolian *Mahāvyutpatti* and relevant Uyghur texts.

[397] This division is essentially Indic. For example, see Varāhamihira (1977: 5-8). To further investigate the terms *sāvana* (T. *nyin zhag*), *saura* (T. *khyim zhag*), and *tithi* (T. *tshes zhag*), see Neugebauer and Pingree (1970: 185-6), Lcang skya III et al. (1982: 52), and Lcang skya III et al. (2002: 1180). This reading will also define *khyim zhag* (M. *ger-ün qonuγ*), *nyin zhag* (M. *edür-ün qonuγ*), and *tshes zhag* (M. *sin-e-yin qonuγ*). Ishihama and Fukuda (1989: 384) presented *ahorātram* (S.) for *nyin zhag,* together with [ML] *edür qonuγ* [MT] *edür qonuγ*. Also see Sárközi and Szerb (1995: 542), Vogel (1997: 679, no. 13).

[398] According to Schuh's position system, this is given as $1+\frac{2}{65}=\frac{[1,2]}{(-,65)}=\frac{67}{65}$. For which, $\frac{67}{65}=1+\frac{4}{130}$ (which reflects the *Laghukālacakra* I. 27. See Schuh (1973a: 121)). The ratio $\frac{67}{65}$ means that the period of 67 lunar months (T. *tshes zla*) is equal to that of 65 solar months (T. *khyim zla*). See Schuh (1973a: 4-5), Schuh (1974: 561).

nyin zhag $\times 1 - \frac{(1+\frac{1}{707})}{64}$.[399] One *tshes zhag* $= \frac{65}{67}$ *khyim zhag* $= \frac{11135\ (nyin\ zhag\ gi\ cha)}{11312\ (tshes\ zhag\ gi\ cha)}$ *nyin zhag*.

1.2. METHODS WITHIN THE *KĀLACAKRA* RELIGIOUS FRAMEWORK

1.2.1. ADDITION OF VALUES (T. *NUR STER*) TO LONGITUDE (T. *LONGS SPYOD*)

THE DIFFERENCE BETWEEN *PHUG PA GRUB RTSIS* AND *BYED RTSIS*: *RTAG LONGS*

Two different systems of calendrical calculations, *siddhānta* and *karaṇa,* are included in the *Kālacakra*[400], which was an inherent conundrum in creating calendrical systems in Tibet. The *grub rtsis* formulated by *Phug pa* scholars has different *rtag longs* from *byed rtsis*.[401] The following table is presented on the basis of previous research.[402]

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[399] According to Schuh's position system, this is given as $1 - \frac{(1+\frac{1}{707})}{64} = 1 - \frac{[0,1,1]}{(-,64,707)}$. See Schuh (1973a: 73), Schuh (1974: 561).

[400] The discrepancy between *siddhānta* and *karaṇa* has a long history in India. See Pingree (1981: 17-40). In particular, Pingree (1981: 32) states that "*Karaṇa*s outside of South India are distinguished from *siddhānta*s by their emphasis on pragmatic rules for computing and their avoidance of astronomical theory." Also, for further information on the principle and calculations based upon the different systems in Indian astronomy, see Plofker (2009).

[401] I appreciate Henning's (Unpublished (1)) rigorous foundation for the formation of the Tibetan *grub rtsis* made in the 15th century. Because I focused on 18th century Tibetan astronomy and did not research other *grub rtsis*-s except for *Phug pa grub rtsis*, "*grub rtsis*" in this manuscript indicates the *Phug pa grub rtsis*, unless otherwise indicated. Also, I occasionally used "*Phug pa grub rtsis*," but it is just for the purpose of emphasis.

Table 12.

	Phug pa grub rtsis[403]	*byed rtsis*
khyim lo[404]	365 *nyin zhag,* 16 *chu tshod*, 14 *chu srang*, 1 *dbugs*, 12(13) (*cha shas*), 121(707) (*cha shas*) = 365.27065 *nyin zhag*[405]	365 *nyin zhag,* 15 *chu tshod*, 31 *chu srang*, 3 *dbugs*, 2(13) (*cha shas*), 571(707) (*cha shas*) = 365.25867 *nyin zhag*

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[402] For these values, see Huang and Chen (1987: 228). For Schuh's research into the Sde srid's *Vaiḍūrya dkar po*, see Schuh (1973a: 89-96).

[403] Yum pa (2006: 144-5) is an investigation into the differences between the *Phug* system and the *Mtshur* system. There is no difference with the above table in the case of *byed rtsis*, but in the case of *grub rtsis*, there is a significant difference in *rtag longs dkyil 'khor* and *rtsis 'phro* among the three following traditions.

	Grub rtsis		
	Phug lugs (*Vaiḍūrya dkar po*)	*Mtshur lugs* (*Legs bshad kun 'dus*)	*Mtshur lugs byed grub zung 'brel*
gza'i tshes zhag rtag longs	$0^{z}59^{q}$3'4"16"'(707)	$0^{z}59^{q}$3'4"0"'(13)208""(707)	$0^{z}59^{q}$3'4"1"'(44)
nyi ma'i tshes zhag rtag longs	$0^{k}4^{q}$21'5"43"'(67)	$0^{k}4^{q}$21'5"8"'(13)23""(67)	$0^{k}4^{q}$21'5"26"'(38)
nyi ma'i dkyil 'khor (*nyin zhag*)	365.27065	365.27065	365.26079
tshes zla gcig gi dkyil 'khor (*nyin zhag*)	29.53059	29.53059	29.53059

[404] See Ōhashi (1997: 136): The *grub rtsis* system and the *byed rtsis* system in Tibetan astronomy are basically similar, and only the length of the year and months are different. In the *grub rtsis* system, one sidereal year = 365.27065 days and one synodic month = 29.53059 days. In the *byed rtsis*, a sidereal year = 365.25867 days, while a synodic month = 29.53056 days. The numbers in the table are rounded to the nearest hundred thousandths (5 decimal places).

[405] Schuh (1973a: 89-90): The period of the sun's *tshes zhag dkyil 'khor* is 371 *tshes zhag*, 4 *chu tshod*, 36 *chu srang*, 5 *dbugs*, 7 *cha shas*(13) = the Sun's *nyin zhag dkyil 'khor* 365 *nyin zhag*, 16 *chu tshod*, 14 *chu srang*, 1 *dbugs*, 12 *cha shas*(13), 121 *cha shas*(707) = decimally 365.27065 days.

Table 12 (continued)

tshes zla'i dkyil 'khor	29 *nyin zhag*, 31^{q}50'0"480"'(707) [= 45"' (67)/ 345"" (707) (*cha shas shed snyoms*)] = 29.53059 *nyin zhag*[406]	29 *nyin zhag*, 31 *chu tshod*, 50 *chu srang* = 29.53056 *nyin zhag*
zla ba'i rtag longs (*nyin zhag*)	*zla ba'i dkyil 'khor*: 27.32174 day (*nyin zhag*).[407] daily movement: 0^{z}59^{q}17'3"95367(149209)[408]	
zla ba'i rtag longs (*tshes zhag*)	*zla ba'i dkyil 'khor*: 27.75604 day (*tshes zhag*). daily movement: 0^{z}58^{q}21'5"43"'(67)[409]	0^{z}58^{q}21'5"9"'
gza'i rtag longs (*tshes zhag*)[410]	0^{z}59^{q}3'4"16"'(707)[411]	0^{z}59^{q}3'4"0"'[412]
nyi ma'i rtag longs (*tshes zhag*)	0^{k}4^{q}21'5"43(67)[413]	0^{k}4^{q}21'5"9(13)[414]

406 Schuh (1973a: 93).

407 Schuh (1973a: 95-6): The period of the moon in *tithi* corresponds to *grub rtsis zla ba'i tshes zhag dkyil 'khor*, 27. 75604 days $(27 + \frac{657}{869})$, which equals decimally 27.32174 days, according to *grub rtsis zla ba'i nyin zhag dkyil 'khor*. Also, see Huang and Chen (1987: 228) for further information.

408 See Schuh (1973a: 96), and Huang and Chen (1987: 228).

409 Schuh (1973a: 94).

410 Schuh (1973a: 118).

411 Schuh (1973a: 91).

412 see m = 2 in Schuh (1973a: 118).

413 Henning (2007: 265): 0^{k}4^{q}21'5"8(13)23(67) = 0^{k}4^{q}21'5"43(67). See Huang and Chen (1987: 228).

As seen above, the *rtag longs* discrepancy between *Phug pa grub rtsis* and *byed rtsis* is fractions of seconds per year and month reckonings. However, it is not difficult to speculate that the different mean longitudes of the sun and moon caused by it may influence the results of eclipse calculations. [415]

NUR STER FOR ACCURACY OF ECLIPSE CALCULATIONS

Because of the longitudinal differences between *Phug pa grub rtsis* and *byed rtsis*, *nur ster* or *nur phri* has often been considered for the purpose of correspondence between *rtsis* and real eclipse phenomena. This means that either values must be added to the longitude of the sun / moon, or values must be subtracted from *sgra gcan dong* (ascending

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[414] see m = 2 in Schuh (1973a: 118).

[415] The general Tibetan conception is as follows: the temporal (T. *gza'*) values are more accurate in the *grub rtsis* system, meanwhile the spatial (T. *skar*) values are more accurate in the *byed rtsis* system. Therefore, it follows that the latter is more accurate than the former for eclipse calculations. To illustrate some examples in Tibetan *rtsis* texts, Sum pa Mkhan po (2015a: pdf 331-2) states: "It is known that there are certaintly possibilities for eclipse in *byed rtsis* and in *grub rtsis* for timing, etc.." (*'dzin dang mi 'dzin byed rtsis dang / 'dzin dus sogs la grub pa nges zhes grags /*). Similarly, Gser tog (2015: pdf 81) writes: "It is said that lunar eclipses are examined by *byed rtsis* and solar eclipses by *grub rtsis*, but in case that solar eclipse does not arise in *byed rtsis*, *grub rtsis* is also not comprehended as accurate in the case that the solar eclipse occurs. Therefore, corrected *byed rtsis* (*rnam dag byed rtsis*) is good for [deciding] the occurrence of an eclipse. Timing is mainly based on the planetary longitude of *grub rtsis*." (*zla 'dzin byed pa nyi 'dzin grub par brtags / zer yang nyi 'dzin byed pa ma shar na / grub kyang shar ltar mi 'dzin de yi phyir / 'dzin dang mi 'dzin rnam dag byed pa bzang / dus tshod grub pa'i res gza'i longs spyod gtso /*).

node) / *sgra gcan mjug* (descending node).[416] Phyag mdzod summarizes the *nur ster* explained in the *Nyin byed snang ba,* which computes how far either the value of *sgra gcan gdong* — 31^{q}41'4"10"' or that of *sgra gcan mjug* — 31^{q}41'4"10"' varies from *zla yi longs spyod* (longitude of the sun / moon), according to the *grub rtsis* in order to elucidate the possibility of a lunar eclipse.

> *de yang gdong mjug gang rung la / chu tshod gzugs me (31) srang zla mtsho (41) dbugs chu (4) cha shas mkha' zla (10) yis / phri ba bslu ba med pa'i gzer / de dang grub mtha'i zla nyi yi / longs spyod gang nye dang bstun nas / brtag pa nyin byed snang ba'i lugs / .*[417]
>
> Furthermore, subtracting 31^{q}41'4"10"' from *sgra gcan gdong*, *sgra gcan mjug*, whatever is appropriate, is an infallible determinant. Investigating after comparing the value and the longitude of the sun / moon in the *grub mtha'* (= *grub rtsis*), whatever is close, is the method of the *Nyin byed snga ba.*

The value 31^{q}41'4"10"' has been thought to be "nine fortnights (= 18 weeks = four and half months) of the motion of Rāhu."[418] The application of *nur ster* / *nur phri* is tied to the difference between *grub rtsis* and *byed rtsis* in terms of the longitudinal differences of the sun and moon.

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[416] See *nur byin* in Bsam 'grub rgya mtsho (2011: 94) [= *Bod rgya tshig mdzod chen mo* (2000: 1527)]: "On the occasion of eclipse, the way of subtracting more than 31 *chu tshod*, the longitude of four and half months from, Rāhu head / tail, whichever is closer, or of adding to the longitude of *gza' dag*, etc. ..." (*gza' 'dzin skabs sgra gcan dgong mjug gang rung la chu tshod gzugs me sogs zla ba bzhi dang zla phyed kyi longs spyod kyis phyi ba dang / gza' dag pa'i longs spyod kyi steng du nur ster tshul sogs /... .*). This explanation needs further explanation: Generally, the *nur ster* / *nur phri* is applied to the *tshes 'khyud zla skar* in the case of a lunar eclipse and *nyi dag* in the case of a solar eclipse respectively. Bsam 'grub rgya mtsho may mean the consideration of timing by "adding a value to the longitude of the *gza' dag*." Or, it may be related to the fact that the original draft of Bsam 'grub rgya mtsho (2011) was revised by someone else and published.

[417] Phyag mdzod given by Huang and Chen (1987: 33). See Henning (2007: 101-2).

[418] See Henning (2007: 101).

de'i dbyug gur mig me bsnan pa ni sngar byed rtsis kyi lag len la gzer btab pa dang bstun te phyis skyon gyis mig (*sic.* read *mi*) *chug* (*sic.* read *'chug*) *pa'i slad du grub rtsis la gtan 'bebs byas pa'i gnad sgrib pa ste / 'og tu nyi 'dzin dus bshad pa ltar sgra gcan la ster phri byas kyang don 'dra'o / des na grong rtsis pa phal cher / zla 'dzin grub rtsis las byed rtsis btsan zhes zer ba'ang sngar byed pa'i ri mo la myong rtsis kyis gzer bcos pa'i gnas ma go ba'i 'chol gtam mo / .*[419]

Adding 32 (T. *mig me*)[420] *chu tshod* (S. *ghaṭikā*, *daṇḍa*) to it (longitude of the moon in *grub rtsis*) tallies with the pivotal point previously pinned down in the practice of *byed rtsis*. Later, in order not to be mistaken by errors, the essential point that was decided in the *grub rtsis* is obscured. As the timing of solar eclipses will be explained below, [ ] is of similar meaning also in the case of adding to and subtracting from Rāhu. Then, the statement said by the most of village astronomers, that the *byed rtsis* is more powerful than the *grub rtsis* in the case of lunar eclipse, is also a confused talk without understanding the corrected essential point by the *myong rtsis* about the value in the *byed rtsis* previously."

Dharmaśrī defends the usefulness of *grub rtsis* for eclipse calculations. We do not fully understand his logic, which is as follows: The *byed rtsis* combined with the *myong rtsis* (calculation by observation/ experience)[421] is fundamentally the same with the *grub rtsis* combinded with the *nur ster*. Whether his explanation is persuasive or not, it is certain that the method of *nur ster*/ *nur phri* was developed within the dynamics between *grub rtsis* and *byed rtsis*.

The method of the adjustment of longitude by adding or subracting some values appears to be widespread, even before the *Nyin byed snang ba*. More research is needed to

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[419] Dharmaśrī (1983: 252). For an additional context for this phrase, see Henning (2007: 101-3).

[420] Dharmaśrī (1983: 252) presents the corrected value for *tshes 'khyud zla skar*, i.e. *tshes 'khyud zla skar* + 32^q to judge the possibility of a lunar eclipse. See also Henning (2007: 101).

[421] By this, Dharmaśrī may mean that 806/3/0, the epoch of the *byed rtsis*, was set up by reflecting observational values around the epoch. Further research is needed.

clarify this point, but, for example, Ngag dbang[422] (active in the late 17th c.) mentions that the 16th century Lha dbang blo gros points out that eclipse calculations by the *Pad dkar zhal lung* are not correct in terms of the longitude of the *grub rtsis*.

> *'dzin pa snga phyi'i skor gdan 'dus*[423] *mkhan po lha dbang blo gros kyis zhal lung la skyon brjod pa'i tshes la / gza' 'dzin skabs su zhal lung grub rtsis steng / chu tshod bzhi lnga mi 'grig bsnon dgos*

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[422] For Ngag dbang, see Schuh (1973a: 40): "So wird z.B. die Basis für die *Grub rtsis* der *Phug pa* Schule, d.i. die Gröβe der ausgehend von der groβen Konjunktion errechneten Anfangswerte, nicht in Frage gestellt. Zweifellos war Ngag dbang selbst ein Angehöriger der *Phug pa* Schule." Also see van der Kuijp (2012: 2). He is a teacher of Sum pa Mkhan po's teacher Ngag dbang rgya mtsho. Sum pa Mkhan po's astronomy teachers include Sde pa Lha dbang, Ngag dbang rgya mtsho, and others; see Singh (1991: xiii) and Smith (2001: 169). Smith (2001: 310, n. 529-30) observes: "Sde pa Lha dbang was a Lhasa aristocrat who had studied astronomy and astrology with the Sde srid. ... Thu'u bkwan notes that Ngag dbang rgya mtsho was a student of one La Ngag dbang pa." Among them, La Ngag dbang pa is identified in Sum pa mkhan po's writings. He is the famous Ngag dbang who wrote a letter to the Sde srid to ask questions on the *Vaiḍūrya dkar po*. Sum pa Mkhan po (1997: 34), Sum pa Mkhan po's autobiography in which he describes his activities in Dbus gtsang in 1726, conveys the following fact: "I learned *skar rtsis* and *nag rtsis* from three: Sde ba dang lha dbang ba (Sde pa Lha dbang) from Skyor mo lung, direct student of the Sde srid and Sgo mang ba Sog po Rab 'byams pa Ngag dbang rgya mtsho, who learned astronomy from Lā Ngag dbang, and a common physician". (*skyor mo lung nas sde srid sangs rgyas rgya mtsho'i dngos slob sde ba dang* (*sic.*) *lha dbang ba dang / lā ngag dbang las rtsis bslab pa'i sgo mang ba sog po rab 'byams pa ngag dbang rgya mtsho dang / spyi sman pa gsum las skar rtsis dang nag rtsis skor bslab /*). In Sum pa Mkhan po (1979d: 50a) [= (2001: 129)], the La Ngag dbang (Lā Ngag dbang) appears as Lnga Ngag dbang: "I pretended (Tibetan way of speech in a humble way) to learn *nyin zhag gza' lnga*, etc. from Sde pa Lha dbang from Skyor mo lung, direct student of the Sde srid, *lnga bsdus*, etc. from Sog po Rab 'byams pa Ngag dbang rgya mtsho, a student of Bla mkhyen Lnga Ngag dbang who has reached the other side of astronomy (= expert), to whom the *Baiḍurya'i g.ya' sel* was granted as reply, after having offered *Rtsis baiḍurya dkar po'i nang gi dogs gnas dris pa snyan sgron* (= Ngag dbang (2002)) to the Sde srid, and the displaying way of 45 *rgya rtsis rde'u* of the tradition of *spor thang*, etc. from a common medical donator at the monastery of 'Bras spungs'". (*sde srid sangs rgyas rgya mtsho'i dngos slob skyor mo lung gi sde pa lha dbang las nyin zhag gza' lnga sogs dang / rtsis baiḍurya dkar po'i nang gi dogs gnas dris pa snyan sgron zhes pa sde srid la phul nas lan du baiḍurya'i g.ya' sel byed* (?) *ces pa gnang yul* (*sic.*) */ bla mkhyen lnga ngag dbang zhes rtsis rig gi pha rol tu son pa de'i slob ma sog po rab 'byams pa ngag dbang rgya mtsho las lnga bsdus sogs dang / spor thang lugs kyi rgya rtsis rde'u zhe lnga bkram tshul sogs ni 'bras spungs spyi'i sman sbyin pa bod pa sman rams pa zhig las bslab khul byas /*). Also, in Brag dgon Zhabs drung (1987: 62), the Ngag dbang appears as Lug mgo Bla mkhyen Ngag dbang: "[Sum pa Mkhan po] studied with Sde ba Lha dbang from Skyor mo lung, direct student of the Sde srid, and Sog rams pa Ngag dbang rgya mtsho, a student of Lug mgo Bla mkhyen Ngag dbang who offered the *Bai dkar la snyan sgron* (= Ngag dbang (2002))." (*sde srid dngos slob skyor mo lung gi sde ba lha dbang pa dang / bai dkar la snyan sgron 'bul mkhan lug mgo bla mkhyen ngag dbang gi slob ma sog rams pa ngag dbang rgya mtsho las rtsis dkar nag la sbyangs* /). For a Chinese translation, see Wu Jun et al. (1989: 67). Various titles or regional names such as La (Lā), Lnga, Lug mgo (also in the form of Lu 'go. see above notes 154, 285), etc. are addressed before his name. They are occasionally combined with the title *bla mkhyen*, i.e. court astrologer.

[423] Variations such as *gdan du*, *gdan dus*, etc. appear in the Tibetan *rtsis* texts.

> *na / zhal lung rjes 'brang rnams la mngon sum skyon / zhes par lan chos rje bkod po pas (sic.) mdzad par / gza' 'dzin gyi skabs 'dir mkhas pa snga ma rnams kyi byed pa'i tshes long steng du / nyin mtshan mnyam dus mda' byin zhing / lho byang mthar thug phyogs kyang byin / zhes dang / kha cig tu / nyin mtshan mnyam dus glu* (*sic.* read *klu*) *dang ni / bgrod gnyis mthar thug mi bdag byin / zhes sogs man ngag tu mdzad pa snang yang / grub mtha'i longs spyod byed pa'i tshes kyi nang du ma chud pa'i cha bsnon dgos pa yin la / 'dir ni grub mtha'i longs spyod rnam par dag pa yin pas / snon byed zur pa ma dgos la / ...* [424]
>
> Regarding the earlier and later eclipse, when Gdan dus Mkhan po Lha dbang blo gros explained the errors of the *Pad dkar zhal lung*, he said that if the incorrect 4 to 5 *chu tshod* should be added to the *grub rtsis* of the *Pad dkar zhal lung* on the occasion of an eclipse, the *Pad dkar zhal lung* followers were mistaken in their observations. In Chos rje Bkod po pa's (Grwa phug pa?) reply to him, he (Chos rje) said that here, on the occasion of eclipse, 5 (T. *mda'*) is added to the *tshes long* of the *byed rtsis* of the previous scholars in equinox, and 10 (T. *phyogs*) is also added in *lho byang mthar thug.*[425] Although in some cases, there appears to have been oral instruction (T. *man ngag*) saying 8 (T. *klu*) in equinox, 16 (T. *mi bdag*) in *bgrod gnyis mthar thug*[426], the longitude of the *grub mtha'*, *cha* (*cha shas*) that were not included in the *tshes*[427] of the *byed rtsis* needs to be added [to the longitude of the *byed rtsis*] because, in this case, the longitude of the *grub mtha'* is accurate and does not warrant further additions.

In the above passage, the answer to the question as to why an eclipse cannot be predicted accurately by the *grub mtha'* (S. *siddhānta*) corrections to the longitude of the sun is : the

[424] Ngag dbang (2002: 378-9).

[425] Bsam 'grub rgya mtsho (2011: 117): "southward movement: to take the sun as an example, the sun goes south during 6 *khyim zla*, i.e. from *'khrig pa*, (*karka ṭa*, *seng ge*, *bu mo*, *srang*, *sdig pa*) after summer solstice, and is the case that the daytime gets shorter and shorter, and the nighttime gets longer and longer." (*lho bgrod: nyi ma la mtshon na dbyar nyi ldog nas 'khrig pa sogs khyim zla drug la nyi ma lho bgrod de / nyin je thung dang mtshan je ring 'gro ba'i skabs so /*). Bsam 'grub rgya mtsho (2011: 117): "northward movement: to take the sun as an example, the sun goes north during 6 *khyim zla*, i.e. from *gzhu*, (*chu srin*, *bum pa*, *nya*, *lug*, *glang*) after winter solstice, and is the case that the daytime gets longer and longer, and the nighttime gets shorter and shorter." (*byang bgrod: nyi ma la mtshon na dgun nyi ldog nas gzhu sogs khyim zla drug la nyi ma byang bgrod zer te / nyin je ring dang mtshan je thung du 'gro ba'i skabs so /*).

[426] See above note 425.

[427] It is difficult to make sense of '*tshes*' here. I conjecture the author means the difference of *gza' dag* between *grub rtsis* and *byed rtsis* by it.

byed rtsis is wrong. They talk at cross purposes! But, the problem of how to defend *grub rtsis* lingers.[428]

At this point, the audience may ask why Tibetans did not change *rtag longs* on the basis of observation and empirical data, that are assumed to have been made continuously. Mi pham's opinion on *rtag longs,* regarding the motion of the sun, moon, and rāhu in the following paragraph, may show the Tibetan normative approach to the *rtag longs* involved in eclipse calculation. A criticism towards the *Rtsis gsar thub bstan mdzes rgyan* written by Rnga ban Kun dga' reads as follows:[429]

> *... spyir bod snga rabs pa'i rtsis thams cad nyung ngu'i byed pa la brten pa'i rtsis kyi dbang gis longs spyod nyung ba yin zer nas longs spyod mang du btang ba / de dang shed snyams pa'i phyir sgra gcan gyi longs spyod mar phri nas zla phyed nyer dgu zhag bzhi brgya so lnga tsam gyis snga ma rnams las nyung ba 'di / nyi ma phyir bsnur ba dang bsgrig pa'i ched du sgra gcan de tsam yar ded pa las / rgyud las 'di ltar bstan rigs pas 'di ltar 'thad zer ba'i gtan tshigs mi snang ste / sgra gcan dus rgyun mig skar dang bsgrig rgyu ni med / gal te rtsis snga ma rnams kyis nyi zla'i longs spyod nyung ba'i skyon yin na nyi zlar bsnan pa'am / yang na sgra gcan gdong mjug la de tsam bri bas 'grig pa'am / ...*[430]
>
> ... This one whose [longitude of Rāhu] is smaller than the previous ones by 435 days (15 (*zla phyed*. half-month) × 29 = 435 days), having subtracted Rāhu's longitude in order to equalize the increase of the longitude [of the sun], after having said that generally the longitude of [the sun] in all Tibetan predecessors' calculations is small because of there being the calculations based upon the smaller *byed rtsis* (*nyung ngu'i byed rtsis*): moved Rāhu forward by that much in order to match the sun's moving backward. [However,] an argument that should be taught this way is not seen in the *Kālacakra*, and Rāhu is not that which should always match up with the observation (*mig skar*). If the previous astronomers erred in terms of the small longitude of the sun and moon, it would be fine to

[428] Regarding this, Henning's (2007: 307) opinion may work: "Rather than the *siddhānta* providing highly accurate calculations for the calendar, it instead provides a methodology for regular observation and correction of the calendar, based on the solsticial adjustment to the longitude of the Sun."

[429] Rnga ban Kun dga' appears in Karma Phun tshogs (2005: 54). He is a contemporary of Mi pham.

[430] Mi pham (2012b: 392-3).

add [that much] to the sun and moon or to subtract that much from Rāhu's head and tail … .

Tibetan astronomers are ready to refute anything that contradicts the *Kālacakra*. Asking how to enhance the accuracy of eclipse calculations within the frame of *skar rtsis* buttressed by the *Kālacakra,* may be equal to asking which trials cannot be made within the frame of the *Kālacakra*.

1.2.2. CORRECTION OF CALCULATION REMAINDERS (T. *RTSIS 'PHRO*)

The different calculational systems in Tibet are explained by the correction *rtsis 'phro.*[431] Schuh (1973a) and Henning (2013) present exellent research into this subject.[432] Tibetan astronomers' corrections of *rtsis 'phro* are tied to enhancing the

[431] See Schuh (1973a), Schuh (2012a), Henning (2007: especially, chapter 6), and Janson (2014: 38-54).

[432] Schuh (1973a: 71-6, 116-23): Ten (eleven if old and new *Phug* systems (according to Schuh's terms) are counted separately) different caldendar systems are given according to different solar (SO(m,n)) and lunar (MO(m,n)) constants [= S(m,n) and W(m,n), respectively in Schuh (2012a)]. Among them, he demonstrates the first three (four) cases (m = 1A (1B), 3, 4) in his tables. His explanation is as follows: First, m = 1 indicates old *Phug pa* [m = 1B] and new *Phug pa* [m = 1A] systems (both are *grub rtsis*). In the case of *byed rtsis*, firstly, m = 2 is 'so-called exact *byed rtsis*' (sogenannte exakte *Byed rtsis*). He calls it *Phug pa*'s new *byed rtsis*. Schuh (1973a: 75): "die durch die Verwendung der Werte, SO(2,1) [= S(2,1) in Schuh (2012a)] = SO(3,1) [= S (3,1)], SO(2,2) [= S(2,2)] = SO(2,1) [= S(2,1)], SO(2,3) [= S(2,3)], MO(2,1) [= W(2,1)] = MO(3,1) [= W(3,1)], MO(2,2) [= W(2,2)] = MO(2,1) [= W(2,1)], MO(2,3) [= W(2,3)] charakterisiert ist, kaum vor dem 14. Jahrhundert stattgefunden haben. … dieser Typ der *Byed rtsis* um die Mitte des 15. Jahrhunderts im Gebrauch gewesen ist." Hence, m = 3 is the *byed rtsis* from the *Laghukālacakra*. Schuh (1973a: 74) explains it: "Die Verwendung der Werte MO(3,1) und SO(3,1) in der Kalenderrechnung ist für die tibetische *Byed rtsis* charakteristisch und wurde von allen Astronomen verwendet, die nicht bereit waren, von den Zahlenangaben der Kalenderrechnung des *Kālacakratantra* zugunsten der rekonstruierten *Grub rtsis* vollständig abzuweichen." m = 4 is 'Phags pa's *byed rtsis*. Schuh (1973a: 74-5): "Für seine Kalenderrechnung verwendet 'Phags pa SO(3,1), MO(3,1) und MO(3,3). Anstelle von MO(3,2) rechnet er mit MO(3,1) und

agreement between *rtsis* and the phenomenon of eclipse, as perceived by direct

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anstelle von SO(3,3) gebraucht er SO(6,3). ... An der *Byed rtsis* des 'Phags pa zeigt sich insbesondere, dass die *Skar rtsis* im 13. Jahrhundert wenig mehr ist als eine unkritische Aufnahme und Auswahl dessen, was in den Sanskrit-Texten vorgegeben war." Schuh's explanations leave something to be desired. First, let us look into m = 1A and m = 1B. Aside from the incorrect intercalation in m = 1A (See Yamaguchi's excellent research (1992: 890), (1990: 31) and Schuh (2008: 209ff.)), it begs the question of if his division of the old and the new *Phug pa,* with 1696 as a watershed, can be justified. For an explanation, see Schuh (1973a: 138-9): "... die Kalenderreform des Übergangs von der älteren *grub rtsis* zur neueren *grub rtsis* der *Phug pa* Schule 1696 wirksam geworden ist. ... Die Kalenderreform ist also offenbar erst nach dem Tod des 5. Dalai lama realisiert worden." However, the demarcation between the new *Phug pa* and old *Phug pa* systems in 1696 C.E. is a hasty conclusion based upon Ahmad Zahiruddin's *Sino-Tibetan Relations in the Seventeenth Century* (1970). See also Schuh (2008: 236), Schuh (2012a: 115): "Diese neue Methode der Einfügung von Schaltmonaten wurde im Verwaltungsbereich der zentraltibetsichen Regierung im Jahre 1696 nach dem Tod des 5. Dalai Lama eingeführt."Of course, it is highly possible that the new the intercalation method, in which the *mda' ro lhag ma* 48, 49 indicates intercalation, began to be used in the 17th century. However, it is difficult to know in which text the *mda' ro lhag ma* 48, 49 (50, 51 in leap months) began to be used. — Regarding this, see Janson (2014: 57, n.68). The change of the *mda' ro lhag ma* into 49, 49 may be closely tied to the introduction of the concept of the *sgang*. It should be noted that the *sgang* (precisely *bod sgang*) is not the same as the Chinese *zhongqi*. It is easily verified from a *lo tho* that the dual system, which uses both *bod sgang* and *rgya sgang*, is used. The *bod sgang* is interrelated with the *mda' ro lhag ma* with regards to the decision of intercalation; the *rgya sgang* is basically the same as the *zhongqi* in the Chinese lunar calendar. — In the same vein, a larger problem is that we do not know which *mda' ro lhag ma* was used in the *Phug* system before 48, 49. It is highly possible that *Phug pa* scholars used 63, 64 (65, 66 in leap months) like *byed rtsis* —this dates back to Grags pa rgyal mtshan— or 65, 66 (0, 1 in leap months) like *Mtshur phu grub rtsis* but I wonder whether Schuh has any textual evidence. For Schuh's opinion, read Schuh (1973a: 110-2). Another relevant problem is that we do not know whether the terms old *Phug* / new *Phug* can be justified or ever existed in Tibetan literature. During a personal talk, Yum pa once communicated that, according to his long-time reading of Tibetan *rtsis* literature, *Phug pa snga ma* of Dpal mgon 'phrin las pa / *Phug pa gsar ma* beginning from Lhun grub rgya mtsho may be the proper way of the classification for the *Phug* system, as seen in real *rtsis* literature. Next, let us briefly mention his explanation of the *byed rtsis*. Aside from the *byed rtsis* (m = 5, 6, 7) in Abhayākaragupta's *Kālacakrāvatāra*, he does not present m = 2, which would be the most useful for modern Tibetan historians. Instead, he presents m = 3 (*Laghukālacakra* system according to him), 4 ('Phags pa's *byed rtsis* system according to him). First off, I do not know why m = 4 exists independently of m = 2, which is currently known as the *byed rtsis* system and dates back to Rje btsun, this also means that this system was used by Sa skya pa scholars, one of whom is 'Phags pa, and supported also by Bu ston. In other words, I am not sure whether 'Phags pa's *byed rtsis* is different from m = 2. I understand that 'Phags pa's texts *Lnga bsdus sgra gcan gza'i lnga dang bcas pa'i rtsis gzhi* (epoch: 1248), *Dus gsal ba'i sgron me* (epoch: 1267), and *Dhru va gnyis pa'i rtsis* (epoch: 1252) [with some corrections of the values in the latter part of it] are m = 2. In addition, *Rtsis kyi gtsug lag dang mthun par nges pa* (epoch: 1264) is different from the three texts in terms of *mda' ro lhag ma*, *ril cha*, *gza'*, and *nyi ma*, etc.. Regarding the last text, there is an explanation in Schuh (1973a: 102). I believe that he could have presented his relevant bases and detailed explanations pertaining to how the 'Phags pa's texts have been reflected in the tables in Schuh (1973a). My current line of thinking is also applied to m = 3. I think that a detailed explanation, which pinpoints the relationship between the *Laghukālacakra* and his results in the corresponding table, should be given for m = 3. Lastly, even when assuming that Schuh (1973a) and Schuh (2012a) are correct, I am wondering if evidence exists that supports the concept that m = 3 and m = 4 were used in real Tibetan texts.

experience (*mngon sum*). In the following, I first sketch the general issues of the *rtsis 'phro* and then the 18th Century technical considerations of *Phug pa* in conjunction with eclipse predictions.

RTSIS 'PHRO **VALUE AT EPOCH**

The debate seen in Schuh (2008) and Henning (2013c) is a nice tool to understand the basic concepts involved.[433] To balance these two opposing sides, we will beginning with the Sde srid's *Vaiḍūrya dkar po.* The epoch date is 1687/3/0.[434] The epoch data given in 1687/3/0 are as follows:

Table 13.

	1687/2/30 (= Apr 11, 1687)	**1687/3/0**[435]	1687/3/1 (= Apr 12, 1687)
bshol 'phro (= *mda' ro lhag ma*)	13	**15**	**15**
gza' dhru'i 'phro (= *gza' dhru*)	$5^{z}39^{q}7'2''212'''$	$\mathbf{0^{z}10^{q}57'2''692'''}$	$\mathbf{0^{z}10^{q}57'2''692'''}$

433 See Schuh (2008: 238-9) and Henning (2013c).

434 Day 0, the time of border between day 30 and day 1, is introduced merely for convenience in Henning (2013c) and in this text. Of course, the day does not exist in real calendars.

435 The values highlighted in bold are to demonstrate how the epoch values are arranged.

Table 13 (continued)

ril cha'i 'phro (= *ril cha*)	16/32	**18/33**	**18/33**
nyi dhru'i 'phro (= *nyi dhru*)	24^{k}18^{q}48'2"10"'	**26^{k}29^{q}46'3"27"'**	**26^{k}29^{q}46'3"27"'**
gza' dag	**0^{z}1^{q}58'2"6"'308""**	**0^{z}1^{q}58'2"6"'308""**	0^{z}58^{q}18'1"31"'572""
nyi dag	**26^{k}40^{q}33'0"54"'**	**26^{k}40^{q}33'0"54"'**	26^{k}44^{q}57'0"6"'
rtsa	**24^{k}32^{q}5'1"7"'**	**24^{k}32^{q}5'1"7"'**	24^{k}32^{q}19'1"19"'
gdong	**2^{k}27^{q}54'4"16"'**	**2^{k}27^{q}54'4"16"'**	2^{k}27^{q}40'4"4"'
mjug	**15^{k}57^{q}54'4"16"'**	**15^{k}57^{q}54'4"16"'**	15^{k}57^{q}40'4"4"'

Then, how are the epoch values decided? The major principles are as follows: epoch values mainly concern *gza' dhru, ril cha*, and *nyi dhru*. Firstly, at 3/0 (= epoch), *gza' bar* is valued at 2/30, equal to the *gza' dhru* value of the third month, and the *nyi bar* value at 2/30 equals the *nyi dhru* value of the third month (3/0 is included). For the calculation of *gza' dag* and *nyi dag* at 3/0 (= epoch), the *ril cha* of the second month is used. The *mda' ro lhag ma*, *gza' dhru'i 'phro*, *ril cha'i 'phro*, and *nyi dhru'i 'phro* values are the same with those at 3/1. *gza' dag*, *nyi dag*, and *rtsa gdong mjug* values are the same as those at 2/30.

The epoch date of 1927 has been debated between Schuh and Henning. Let us fist look at the table below. Schuh (2008) says that 1927/2/30 equals the modern date, May 1, 1927 and 1927/3/1 equals 2 May 1927. Therefore, the epoch should be 2 May 1927.

Table 14.

	1927/2/30	**1927/3/0**	1927/3/1
bshol 'phro	55	**57**	**57**
gza' dhru 'phro	6^{z}57^{q}53'2"20"'	**1^{z}29^{q}43'2"500"'**	**1^{z}29^{q}43'2"500"'**
ril cha'i 'phro	13/103	**15/104**	**15/104**

Table 14 (continued)

nyi dhru 'phro	$25^{k}9^{q}10'4''32'''$	**$0^{k}20^{q}8'5''49'''$**	**$0^{k}20^{q}8'5''49'''$**
gza' dag	**$1^{z}31^{q}29'1''36'''473''''$**	**$1^{z}31^{q}29'1''36'''473''''$**	$2^{z}25^{q}28'3''43'''30''''$
nyi dag	**$0^{k}31^{q}0'0''0'''$**	**$0^{k}31^{q}0'0''0'''$**	$0^{k}35^{q}20'0''0'''$
rtsa	**$22^{k}4^{q}10'2''14'''$**	**$22^{k}4^{q}10'2''14'''$**	$22^{k}4^{q}24'3''3'''$
gdong	**$4^{k}55^{q}49'3''9'''$**	**$4^{k}55^{q}49'3''9'''$**	$4^{k}55^{q}35'2''20'''$
mjug	**$18^{k}25^{q}4'3''9'''$**	**$18^{k}25^{q}4'3''9'''$**	$18^{k}25^{q}35'2''20'''$

On the other hand, Henning (2013c) argues that epoch data are based upon the mean sun.[436] In other words, 1927/3/0 is not an epoch. Therefore, what is the correct epoch date? There is an explanation based upon Julian dates in Henning (2013c), which is a sufficient explanation, but in this text I use a possible Tibetan interpretation.[437] 3/0 is not always the epoch date. For more information on the matter, please see the following tables, which show the differences between the values at 2/0 and those at 3/0.[438]

[436] Henning (2013c).

[437] I say 'possible,' because I have not yet found the Tibetan textual description that substantiates this argument.

[438] The same calendrical system is used again by a mere change in *rtsis 'phro* values. It is called *rtsis 'go bstungs pa / spos pa*. It is customarily made every sixty years. This concept is also related to *stong 'jug*. See below note 589. In other words, the three texts, Huang and Chen (1987), Mkhyen rab nor bu (1976), and *Bod ljongs gnam rig skar rtsis rig gzhung tshogs pa* (1985) are the same calendar with different epoch data.

Table 15.

	Phyag mdzod. Huang and Chen (1987)[439]	Phyag mdzod. Mkhyen rab nor bu (1883-1962) (1976) [440]	*Bod ljongs gnam rig skar rtsis rig gzhung tshogs pa* (1985) [441]
epoch	1827/2/0	1927/2/0	1987/3/0[442]
bshol 'phro	60	55	0
gza' dhru'i 'phro	$3^{z}37^{q}43'2''140'''$	$6^{z}57^{q}53'2''20'''$	$3^{z}11^{q}27'2''332'''$
ril cha'i 'phro	22/0	13/103	21/90
nyi dhru'i 'phro	$24^{k}59^{q}6'1''41'''$	$25^{k}9^{q}10'4''32'''$	$0^{k}0^{q}0'0''0'''$

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[439] Huang and Chen (1987: 140).

[440] The epoch of Mkhyen rab nor bu (1976) was changed by Mkhyen rab nor bu into 1927 from Phyag mdzod, i.e. Huang and Chen (1987), whose epoch is 1827.

[441] The epoch is 1987. The text in Yum pa's collection (possibly written in 1987) and Tshul khrims rgyal mtshan (2009) are the same calendars.

[442]

	1987/2/30	**1987/3/0**	1987/3/1
bshol 'phro	65	**0**	**0**
gza' dhru 'phro	$1^{z}39^{q}37'1''559'''$	**$3^{z}11^{q}27'2''332'''$**	**$3^{z}11^{q}27'2''332'''$**
ril cha'i 'phro	19/89	**21/90**	**21/90**
nyi dhru 'phro	$24^{k}49^{q}1'4''50'''$	**$0^{k}0^{q}0'0''0'''$**	**$0^{k}0^{q}0'0''0'''$**
gza' dag	**$2^{z}58^{q}9'4''50'''428''''$**	**$2^{z}58^{q}9'4''50'''428''''$**	$3^{z}58^{q}54'5''9'''86''''$
nyi dag	**$0^{k}11^{q}0'0''0'''$**	**$0^{k}11^{q}0'0''0'''$**	$0^{k}15^{q}20'0''0'''$
rtsa	**$1^{k}10^{q}26'0''12'''$**	**$1^{k}10^{q}26'0''12'''$**	$1^{k}10^{q}40'1''1'''$
gdong	**$25^{k}49^{q}33'5''11'''$**	**$25^{k}49^{q}33'5''11'''$**	$25^{k}45^{q}19'4''22'''$
mjug	**$12^{k}19^{q}33'5''11'''$**	**$12^{k}19^{q}33'5''11'''$**	$12^{k}19^{q}19'4''22'''$

Table 15 (continued)

	1827/3/0[443]	1927/3/0
bshol 'phro	62	57
gza' dhru'i 'phro	$5^{z}9^{q}$33'2"620"'	$1^{z}29^{q}$43'2"500"'
ril cha'i 'phro	24/1	15/104
nyi dhru'i 'phro	$0^{k}10^{q}$4'2"58"'	$0^{k}20^{q}$8'5"49"'

In the case of 1827 and 1927, 1827/2/0 and 1927/2/0 are epoch dates. In the case that the *mda' ro lhag ma* is larger than 49[444] and less than 66 in the *grub rtsis*, 2/0 is chosen as the epoch date. The rationale is as follows: the *zla dag* increases between *mda' ro lhag ma* 49 and 66, i.e. the period (cycle) of intercalation that is not yet done. Simply put, in case that a leap month exists, the second month is actually the third one.[445] Therefore, the epoch date is 2/0. In the case of 1987, there is no such indication by *mda' ro lhag ma*, which

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443

	1827/2/30	**1827/3/0**	1827/3/1
bshol 'phro	60	**62**	**62**
gza' dhru 'phro	$3^{z}37^{q}$43'2"140"'	**$5^{z}9^{q}$33'2"620"'**	**$5^{z}9^{q}$33'2"620"'**
ril cha'i 'phro	22/0	**24/1**	**24/1**
nyi dhru 'phro	$24^{k}59^{q}$6'1"41"'	**$0^{k}10^{q}$4'2"58"'**	**$0^{k}10^{q}$4'2"58"'**
gza' dag	**$5^{z}1^{q}$29'0"0"'534""**	**$5^{z}1^{q}$29'0"0"'534""**	$6^{z}4^{q}$33'0"45"'293""
nyi dag	**$0^{k}21^{q}$0'0"0"'**	**$0^{k}21^{q}$0'0"0"'**	$0^{k}25^{q}$20'0"0"'
rtsa	**$11^{k}51^{q}$23'2"0"'**	**$11^{k}51^{q}$23'2"0"'**	$11^{k}51^{q}$37'3"9"'
gdong	**$15^{k}8^{q}$36'3"3"'**	**$15^{k}8^{q}$36'3"3"'**	$15^{k}8^{q}$22'2"14"'
mjug	**$1^{k}38^{q}$36'3"3"'**	**$1^{k}38^{q}$36'3"3"'**	$1^{k}38^{q}$22'2"14"'

1827/3/0 cannot be an epoch date. See the *mda' ro lhag ma*, 62.

444 48 and 49 indicate leap months in *grub rtsis* in the system of *Phug pa* in this period.

445 Henning hints at a right answer in Henning (2013c): "Does he disagree that it is the mean new Moon when you calculate for the 3^{rd} month in that year from any previous epoch, before making any intercalary adjustment?"

indicates that the epoch is 3/0. In other words, Henning's (2013c) explanation is correct. The intercalation in *grub rtsis* is also based upon the mean moon.

RTSIS 'PHRO DIFFERENCES AMONG DIFFERENT SYSTEMS 1: KAḤ THOG RIG 'DZIN'S RESEARCH

Kaḥ thog Rig 'dzin systematically classified the *rtsis 'phro* differences among different systems, especially in the *byed rtsis*/ *grub rtsis* tradition in Kaḥ thog Rig 'dzin (1976-1977a) (2006a), written in 1750.[446] First, *byed rtsis* (the values given are those at epoch, 1747/3/0).

Table 16.

	gza' dhru'i 'phro	*ril cha'i 'phro*	*nyi dhru'i 'phro*

[446] See Kaḥ thog Rig 'dzin (1976-1977a: 275-82) [= Kaḥ thog Rig 'dzin (2006a: 104-7).]. It should be noted that Kaḥ thog Rig 'dzin (2006a) is filled with many typographical errors. So, the values in the tables are those which have been corrected by the author of this text. The colophon in Kaḥ thog Rig 'dzin (1976-1977a: 282) [= Kaḥ thog Rig 'dzin (2006a: 107)] shows that the text was written (calculated) in 1750/8 (*khrum* (*sic*. read *khrums*) *zla*)/23 (*dmar phyogs rgyal ba gnyis pa*). For the term, *dmar phyogs rgyal ba gnyis pa*, see above note 110.

Table 16 (continued)

byed rtsis[447]	$1^z39^q5'$ (7/60/6)	24/33	$26^k49^q17'$ (27/60/39)
thams cad mkhyen 'ga' (m = 2 in Schuh's notation)[448]	$1^z38^q10'$[449] (7/60/60)	24/33	$26^k48^q33'5''1'''$[450] (27/60/60/6/13)
Gye ri paṇḍi ta Yab sras	$1^z54^q56'5''376'''$	24/33	$26^k46^q34'0''22'''$
Mtshur phu ba kha cig	not given		

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447 Because Kaḥ thog Rig 'dzin presented the values without any expalanation of how to calculate them, they may be misleading. Actually, the *chu srang* values in these calculations should be subtracted. In other words, the following notations may help the reader understand the values. Notation: $1^z39^q(-5')$(7/60/6), $26^k49^q(-17')$(27/60/39). The calculations are that $1^z38^q10'$ (7/60/60) can be calculated from $1^z39^q5'$ (7/60/6) in the following way:
$5 \div 6 = 0.83333333333$
$0.83333333333 \times 60 = \mathbf{50}$
1^z39^q (7/60) $- 5'$ (6) $= 1^z39^q$ (7/60) $- 50' = 1^z38^q10'$ (7/60/60).
$26^k48^q33'5''1'''$ (27/60/60/6/13) is calculated from $26^k49^q17'$ (27/60/39) in the following way:
$17 \div 39 = 0.43589743589$
$0.43589743589 \times 60 = \mathbf{26}.1538461534$
$26.1538461534 - 26 = 0.1538461534$
$0.1538461534 \times 6 = \mathbf{0}.9230769204$
$0.9230769204 \times 13 = \mathbf{12}$
subtract 17' from $26^k49^q17'$ (27/60/39): 26^k49^q (27/60) $- 17'(39) = 26^k49^q - 26'0''12''' = 26^k48^q33'5''1'''$ (27/60/60/6/13). As seen in the above table, the same values with those of *thams cad mkhyen 'ga'* (m = 2 in Schuh's notation) result. However, this method may be uncomfortable when compared with the *thams cad mkhyen 'ga'*'s. For this calculation method, see Bu ston (1986: 188-93), Dpa' bo (n.d. (1): 27b-30b) [= (n.d. (2): 21b-23b) = Yum pa (2015: pdf 37-41)], 'Bri gung Bstan 'dzin Chos kyi rgyal mtshan (1986a: 7b). The original author of the last text (in the sense that the epoch has been changed by 'Bri gung Bstan 'dzin Chos kyi rgyal mtshan (1986a)) is 'Bri gung Dkon mchog lhun grub. Unfortunately, we do not know who Gye ri paṇḍi ta Yab sras are and how they calculated their *byed rtsis* values.

448 *mda' ro lhag ma* = 29.

449 This value has not been specified in the text. It was calculated by me.

450 Kaḥ thog Rig 'dzin (1976-1977a: 276) [= Kaḥ thog Rig 'dzin (2006a: 104)] conveys an intriguing account on the history of the *byed rtsis*.: "When debating the five places in *nyi dhru zhib rtsis*, some all-knowing ones asserted: $26^k48^q33'5''1'''$ (13) is well-known and reliable, the extraordinary continuation of aural transmission of Bu ston's *byed rtsis* is uninterrupted." (... *nyi dhru zhib rtsis su gnas lngar / rtsod dus thams cad mkhyen 'gas bzhed* / $26^k48^q33'5''1'''$ (13) *de ni grags che khung* (*sic.* read *khungs*) *dang ldan / bu ston gyis* (*sic.* read *gyi*) */ byed rtsis thun min snyan rgyud rgyun* / *chad med* .) Raising the question of when did the debate occur?

Regarding the four different *byed rtsis*-s, he says: "*phyogs mthun na yang rtsa ba'i gnad / lag len mi gcig*."[451] "[they have] the same positions, but the fundamental crucial point and the practices are different."

Next, he presents seven *grub rtsis*-s (*grub rtsis rnam grangs bdun*). The *rtsis 'phro* values given are those of the epoch 1747/3/0).[452]

Table 17.

	gza' dhru'i 'phro	*ril cha'i 'phro*	*nyi dhru'i 'phro*
Bu ston's *Mkhas pa dga' byed*/ Byang bdag *grub rtsis* / Mtshur phu 'Jam dbyangs chen po[453]	2^{z}0^{q}7'0"6"'	24/33	25^{k}59^{q}34'0"12"'(67)
'Gos Lo tsā ba's *'Khrul sel*	0^{z}51^{q}50'3"159"'	24/30	0^{k}36^{q}16'0"48"'
'Bras rtsis brgya rtsa mkhan brgya phrag lugs[454]	1^{z}54^{q}57'4"358"'	24/33	26^{k}11^{q}5'4"37"'(67) 5""(13)
Byang bdag rang bzhed nor bu'i 'phreng / phyi rtsom 'phro	2^{z}0^{q}6'2"134"'	24/33	25^{k}59^{q}33'0"54"'
Mtshur lugs grub rtsis	1^{z}55^{q}27'2"358"'	24/33	26^{k}31^{q}8'5"49"'
Phug lugs (m = 1A in Schuh's notation) most commonly used nowadays	1^{z}52^{q}41'2"524"'	24/19	26^{k}9^{q}37'3"45"'
Bsgrub brgyud mnga' bdag 'brug pa'i srol / gdan du lugs	1^{z}54^{q}45'1"23"'	24/69	26^{k}29^{q}46'3"27"'

451 Kaḥ thog Rig 'dzin (1976-1977a: 276) [= Kaḥ thog Rig 'dzin (2006a: 104)].

452 Kaḥ thog Rig 'dzin (1976-1977a: 277-8) [= Kaḥ thog Rig 'dzin (2006a: 105)].

453 Mtshur phu 'Jam dbyangs chen po is 'Jam dbyangs Don grub 'od zer. Kaḥ thog Rig 'dzin informs us that 'Jam dbyangs chen po's system is identical with Bu ston's.

454 *'Bras rtsis brgya rtsa mkhan brgya phrag lugs? 'Bras rtsis* is generally *nag rtsis* astrology. Interestingly, it also has *skar rtsis* elements according to Kaḥ thog Rig 'dzin.

To give more explanation of this subject, in the case of Bu ston, the method he uses is not clear. However, in this case, the quantity is calculated by using the *rtsis 'phro* of *byed rtsis* and the *rtag longs* of *grub rtsis*. At epoch 806/3/0, *zla dag* = 11639 and *mda' ro lhag ma* = 29. Byang bdag has two different *grub rtsis*-s: earlier writing (*snga rtsom*) and later writing (*phyi rtsom*), which are difficult to pinpoint. It is assumed that the *rtsis 'phro* in his earlier writings (*snga rtsom 'phro*) are identical with Bu ston's *Mkhas pa dga' byed*. In the case of the *rtsis 'phro* in his later writing (*phyi rtsom 'phro*), at epoch 806/3/0, *zla dag* = 11639 and *mda' ro lhag ma* = 30. In the case of 'Gos Lo tsā ba's *'Khrul sel*, Henning's software works magnificently.[455] In the case of *Nyer mkho'i bum bzang,* written by *Karma* Nges legs bstan 'dzin, the epoch is 1732/3/0. The *zla dag* = 186 and *mda' ro lhag ma* = 29.[456] *Bsgrub brgyud mnga' bdag 'brug pa'i srol gdan du lugs* seems to be the calculation method of the tradition of 'Brug pa Bka' rgyud, related to Padma dkar po (1527-1592) and Lha dbang blo gros (16th c.), which the Bhutanese calendar is based on.[457] In the case of *Phug lugs*, which is generally well known, *mda' ro lhag ma* = 25.

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[455] Henning's calculator software 'Tibetan Calendar Software' (Version 1.06) correctly outputs 'Gos Lo tsā ba's *'Khrul sel* value. Henning (2007: 318-20) presents 340/2/0 (Feb 13, 340) as the epoch of the *'Khrul sel*. However, the epoch is not clear in the *'Khrul sel*. According to Yum pa, two epochs may be possible considerations: 806 C.E. like Bu ston's *Mkhas pa dga' byed* and 1461 C.E. (*lcags sbrul*). For more information about the *'Khrul sel*, see van der Kuijp (2006: 10-1) and Henning (2013b).

[456] The *rtsis 'phro* values at the epoch have been presented by Henning (2013).

[457] Martin (1997: 186-7).

RTSIS 'PHRO DIFFERENCES AMONG DIFFERENT SYSTEMS 2: BSAM 'GRUB RGYA MTSHO'S RESEARCH

Bsam 'grub rgya mtsho's research into *rtsis 'phro* variations among the *Phug* systems presents some interesting traditions not presented by Kaḥ thog Rig 'dzin (1976-1977a) (2006a)[458]:

1) Sum pa Mkhan po's *Dga' ldan rtsis gsar* (= *Zla bsil rtsi sbyor dge ldan rtsis gsar* written in 1754),

2) Go shrī Blo bzang mi 'gyur rdo rje's (18th c.) *Yang gsal sgron me* (written in 1767 and again in 1770),

3) Thu'u bkwan III's *Mkhas pa'i snying nor* (written in 1796),[459]

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[458] See Bsam 'grub rgya mtsho (1992). In it, the epoch (*rtsis 'go*) in each tradition has been changed to 1987. For research of a similar kind, see also Mi 'gyur rdo rje, Mig dmar tshe ring, and Yum pa (1998: 25-73), whose epoch in each tradition is also 1987.

[459] Two versions of *Yang gsal sgron me* exist. Both of them have the same epoch, 1747. Go shrī's (1767) colophon in *ka* 1 *ben xia* (本 下) 20 - *ka* 1 *ben shang* (本 上) 21: "Go shrī Chos rje, whose name is Blo bzang mi 'gyur rdo rje wrote completely at 1767 (S. *sarvajit*)/4 (T. *sa ga zla ba*)/9 ... ." (... *go shri chos rje'i ming can blo bzang mi 'gyur rdo rjes / thams cad 'dul gyi lo sa ga zla ba'i yar ngo'i tshes dgu ... rdzogs par sbyar ba'o /* .). For the term *thams cad 'dul gyi lo*, see Appendix I. Go shrī's (1770) colophon in *ka* 1 *ben* (本) 20 *gong* (*shang ershi* (上 20)): "Go shrī Chos rje whose name is Blo bzang mi 'gyur rdo rje ... in 1770 (S. *vikṛti*) / 12 (T. *rgyal zla*)/ 23." (*go shri chos rje'i ming can blo bzang mi 'gyur rdo rjes / ... rnam 'gyur lo'i* (1770 C.E.) *rgyal zla ba'i tshes nyer gsum ... /*). For the term *rnam 'gyur lo*, see Appendix I. The two versions are basically similar, but they have a significant difference: respective *stong chen 'das lo*-s have been presented by him. It is speculated that Go shrī was not content with 1767's [epoch: 1747] calculation of *stong chen 'das lo* for some reason and revised it in 1771 C.E.. For the values in 1987/3/0, see Bsam 'grub rgya mtsho (1992: 190). Interestingly, Blo bzang dpal ldan (1990: 269) wrongly presents Go shrī's (1770) *stong chen 'das lo* as that of the *Dga' ldan rtsis gsar*. Nothing is known about Go shrī, but since the Chinese letters are scribed on the left margin of his text, Go shrī (1767), (1770), it is highly probable that he functioned or was well known in Beijing. For a brief mention of the tradition, also see Yum pa (2006: 104-5).

4) Dmu dge Bsam gtan rgya mtsho's (1914-1993) *Byed mthun* (written in 1984).

All of these texts changed the *rtsis 'phro / stong chen 'das lo* values in the *Pad dkar zhal lung*. However, they belong to the *Phug* systems: the *rtag longs* (mean longitude) of *lnga sgra gza' lnga* and the *dkyil 'khor* (period) of *nyi zla gza' lnga* are the same. Next, I will further explain the specifics of Bsam 'grub rgya mtsho's research.

PAD DKAR ZHAL LUNG

Firstly, the *rtsis 'phro* values of the *Pad dkar zhal lung* are given for the case that the epoch is 1987/3/0.[460]

Table 18.

	tshes zla'i dkyil 'khor (*tshes zla*)	*'khor grangs* (times) [461]	*rtsis 'phro* (*tshes zla*)[462]

[460] See Bsam 'grub rgya mtsho (1992: 61). I do not explain the values here. They are explained using Sum pa Mkhan po's method (See below). The calculation procedure is the same and simple, and therefore does not bear repeating.

[461] The *tshes zla'i dkyil 'khor* and *'khor grangs* values, which are common to the *Phug pa* traditions, are why they are subcategorized into the *Phug pa* and are well summarized in *Bod kyi rtsis rig kun 'dus chen mo,* Vol. 2, (1998: 125).

[462] Note that in the above table given by Bsam 'grub rgya mtsho (1992), not the months left but the elapsed months from the zero point of the period (*tshes zla'i dkyil 'khor*) are given as *rtsis 'phro* (*tshes zla*). I think that the reason why the *rtsis 'phro* values are given that way is that they are related to the concept of the *stong chen 'das lo* (= *stong chen las 'das lo.* years elapsed from the *stong chen* (= *stong chen lo tshogs*, great vacuity)). All relevant calculations are easier if the years elapsed from a great conjunction at the zero point, not the years left, are used.

Table 18 (continued)

gza'	39592[463]	8657[464]	11024
ril cha	3528[465]	253[466]	1224[467]
nyi ma	804	65[468]	0[469]

The table represents the case of *gza'* in this way; the revolutions (8657 times) are completed after 39592 *tshes zla* (period). At 1987/3/0, they were completed after 28568 *tshes zla* (39592 − 11024 = 28568). In other words, 11024 *tshes zla* have already passed. From these values, *gza' dhru'i 'phro* $3^{z}11^{q}27'2''31'''327''''$ at 1987/3/0 can be calculated.[470] In

[463] For the logic behind this value, see Blo bzang dpal ldan (1990: 257).

[464] 39592 × $1^{z}31^{q}50'0''480'''$ (707) ([= $1^{z}31^{q}50'0''45'''$ (67)/ 345'''' (707)] = *gza'i rtag longs* in the *Phug pa grub rtsis* on a *tshes zla basis*) = 8657 (*'khor grangs*) + $0^{z}0^{q}0'0''0'''$.

[465] Blo bzang dpal ldan (1990: 257): 3780 *tshes zhag* × 28 = 105840 *tshes zhag.* 105840 ÷ 30 = 3528 *tshes zla.* Or, *dkyil 'khor* of *ril cha*: 3528 = 28 × 126.

[466] 3528 × 2/1 (*tshes zla*) = 253 (*'khor grangs*) + 0/0 .

[467] 82776132766945179900 (= *Stong chen 'das lo* in 1987) × 12 × 67 ÷ 65 = 1023877088378829609840 *zla dag.*
102387708837882960984 ÷ 3528 = 290214594211686397.34694, (the value rounded to the nearest hundred thousandths (5 decimal places)).
290214594211686397.34694 − 290214594211686397 = 0.34694 .
0.34694 × 3528 = 1224 .

[468] 804 × $2^{k}10^{q}58'1''17'''$ (*nyi ma'i rtag longs* in the *Phug pa grub rtsis* on a *tshes zla* basis) = 65 (*'khor grangs*) + $0^{z}0^{q}0'0''0'''$.

[469] 1023877088378829609840 *zla dag* is divided by 804. The remainder is 0.

[470] For the calculation method, see below note 477.

the case of *ril cha*, the revolutions (253 times) are completed after 2304 *tshes zla*. At 1987/3/0, they are completed after 2304 *tshes zla* (3528 − 1224 = 2304). From these values, *ril cha'i 'phro* 21/90 at 1987/3/0 can be calculated.[471] In the case of *nyi ma*, the revolutions (65 times) are completed after 804 *tshes zla*. At 1987/3/0, they are completed after *tshes zla* (804 − 0 = 804). The 0 in this equation means that it is in the beginning point of the revolution (i.e. the sun has ended the 65 revolutions during the span of 804 *tshes zla*). From these values, *nyi' dhru'i 'phro* $0^{k}0^{q}0'0''0'''$ at 1987/3/0 can be calculated.[472]

The same principle and calculation methods are applied for the calculation of the *stong chen 'das lo,* which is based upon a bigger picture that combines the period of the 10 (9 if *du ba mjug ring* is excluded[473]) planets with the *rtsis 'phro* value of each.[474] Inversely, the *rtsis 'phro* values are also calculated from the *stong chen 'das lo*. In addition, it is assumed that eclipse calculations are verifed by direct experience, which may influence

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[471] For the calculation method, see below note 478.

[472] For these values, see Bsam 'grub rgya mtsho (1992: 58-60). For the method, see below note 479.

[473] For this, see below note 601.

[474] For example, see *tshes zla'i dkyil 'khor* values in the table given by Bsam 'grub rgya mtsho; see below pp. 271 ff. Both the *rtsis 'phro* corrections and the *stong chen 'das lo* corrections concern changes in longitude. The *rtag longs* values are fixed values (= constants). In this sense, their approach does not basically differ from the *nur ster*. In the *skar rtsis* astronomy, which has been conditioned and postulated by the *Kālacakra*, possible solutions for accuracy have no choice but to be limited. Also, the geographical concern, which mostly relates to the calculation of a solar eclipse, was found; see below pp. 287-90.

the decision of *rtsis 'phro* and also influnence the decision of the different *stong chen 'das lo*-s. For more information, see below.

PHUG VARIATION – *DGA' LDAN RTSIS GSAR*

Sum pa Mkhan po's *Dga' ldan rtsis gsar* is one of the earliest examples of a text which changed the *rtsis 'phro* values from the *Pad dkar zhal lung*. To give a brief introduction to Sum pa Mkhan po's astronomical system, Sum pa Mkhan po'i *ma* text is the *Skar nag rtsis kyi snying nor nyung 'dus kun gsal me long,* written in 1754 (epoch 1747), and the *bu* text is the *Rtsis kyi bstan 'chos kun gsal me long gi bu gzhung zla bsil rtsi sbyor dge ldan rtsis gsar* (epoch 1747). In terms of *rtsis 'phro-s*, it is the same with the *Pad dkar zhal lung*; at 1747/3/0, *mda' ro'i lhag ma* is 25, *gza' dhru'i 'phro* is $1^{z}52^{q}41'2''524'''$, *ril cha'i 'phro* is 24/19, *nyi dhru'i 'phro* is $26^{k}9^{q}37'3''45'''$, and *sgra gcan* is 31, which are identical to the *Pad dkar zhal lung*. But, the latter known as the *Dge ldan rtsis gsar*. In this system, at 1747/3/0, *mda' ro'i lhag ma* is 10, *gza' dhru'i 'phro* is $1^{z}55^{q}$ $13'3''333'''$, *ril cha'i 'phro* 24/22, *nyi dhru'i 'phro* $26^{k}39^{q}51'0''18'''$, *sgra gcan* 32. The *stong chen lo'das lo* in 1747 is 894592876762834614360.[475]

[475] See Yum pa's research in Sum pa Mkhan po (2015: Pdf, Intro). For the information included in the *ma* and *bu* text, see Sum pa Mkhan po (2015: Pdf, 98-101) and Sum pa Mkhan po (2015a: Pdf, 277-8) respectively.

The *rtsis 'phro* values of the *Dga' ldan rtsis gsar,* in that case that the epoch is 1987/3/0, are given.[476]

Table 19.

	tshes zla'i dkyil'khor	*'khor grangs*	*rtsis 'phro*
gza'	39592 ⓒ	8657 ⓑ	27126 ⓐ
ril cha	3528 ⓕ	253 ⓔ	470 ⓓ
nyi ma	804 ⓘ	65 ⓗ	494 ⓖ

As seen in the table, the *dkyil'khor* (*tshes zla*) and *'khor grangs* are the same with the above *Pad dkar zhal lung*. These facts are the reason this tradition is also called the *Phug* system. Based upon the table, the *gza' dhru, ril cha*, and *nyi dhru* values are calulated as follows: *gza' dhru'i 'phro*: $1^{z}42^{q}$9'2"34"'618""[477], *ril cha'i 'phro* : 19/92[478], and *nyi dhru'i 'phro*: $25^{k}19^{q}$15'1"23"' at 1987/3/0. [479]

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[476] See Bsam 'grub rgya mtsho (1992: 83).

[477] For the values, see Bsam 'grub rgya mtsho (1992: 82). The Tibetan system may look arcane, but it involves the following calculations. The calculations are traditionally made with *sa gzhong*. It is possible to calculate more than 20 digit numbers with *sa gzhong*, but it is not easy. Because general scientific calculators do not support more than 20 digit numbers, I used a million digit calculator (http://comptune.com/calc.php).
27126 (ⓐ) × 8657 (ⓑ) ÷ 39592 (ⓒ) = 5931.243230955749
5931.243230955749 − 5931 = 0.2432309557486361
0.2432309557486361 × 7 = **1**.702616690240453 (*gza'*)
1.702616690240453 − 1 = 0.7026166902404526 (*thob dor*)
0.7026166902404526 × 60 = **42**.15700141442716 (*chu tshod*)
42.15700141442716 − 42 = 0.157001414427157 (*thob dor*)
0.157001414427157 × 60 = **9**.42008486562942 (*chu srang*)
9.42008486562942 − 9 = 0.4200848656294201 (*thob dor*)
0.4200848656294201 × 6 = **2**.520509193776521 (*dbugs*)
2.520509193776521 − 2 = 0.5205091937765205 (*thob dor*)
0.5205091937765205 × 707=**368** (*cha shas*)
The *cha shas shed snyoms* is as follows:
368 × 67 ÷ 707 = **34**.87411598302687
34.87411598302687 − 34 = 0.8741159830268741 (*thob dor*)
0.8741159830268741 × 707 = **618**

PHUG VARIATION – *YANG GSAL SGRON ME*

Bsam ’grub rgya mtsho presents a hitherto unknown astronomer, Go shrī, who reported the epoch of Go shrī (1767) (1770). It is highly possible that he functioned during the 18th century in Beijing. The *rtsis ’phro* values of the *Yang gsal sgron me*, for Go shrī (1767) in the case that the epoch is 1987/3/0, are given. [480]

For the meaning of *cha shas shed snyoms*, see Bsam’grub rgya mtsho (2011: 34) [= *Bod rgya tshig mdzod chen mo* (2000: 2857)].

478 For the values, see Bsam ’grub rgya mtsho (1992: 82). The calculations are as follows:
470 (ⓓ) × 253 (ⓔ) ÷ 3528 (ⓕ) = 33.7046485260771
33.7046485260771 − 33 = 0.7046485260770975 (*thob dor*)
0.7046485260770975 × 28 = **19**.73015873015873
19.73015873015873 − 19 = 0.7301587301587302 (*thob dor*)
0.7301587301587302 × 126 = **92**

479 For the values, see Bsam ’grub rgya mtsho (1992: 83). The calculations are as follows:
494 (ⓖ) × 65 (ⓗ) ÷ 804 (ⓘ) = 39.93781094527363
39.93781094527363 − 39 = 0.9378109452736318
0.9378109452736318 × 27 = **25**.32089552238806
25.32089552238806 − 25 = 0.3208955223880597
0.3208955223880597 × 60 = **19**.25373134328358
19.25373134328358 − 19 = 0.2537313432835821
0.2537313432835821 × 60 = **15**.22388059701493
15.22388059701493 − 15 = 0.2238805970149254
0.2238805970149254 × 6 = **1**.343283582089552
1.343283582089552 − 1 = 0.3432835820895522
0.3432835820895522 × 67 = **23**

480 See Bsam ’grub rgya mtsho (1992: 89).

Table 20.

	tshes zla'i dkyil 'khor	*'khor grangs*	*rtsis 'phro*
gza'	39592	8657	2393
ril cha	3528	253	2785
nyi ma	804	65	61

According to the table, *gza' dhru'i 'phro*: $1^{z}41^{q}40'4''44'''516''''$, *ril cha'i 'phro*: 20/13, and *nyi' dhru'i 'phro*: $25^{k}9^{q}10'4''32'''$ at 1987/3/0.[481] Go shrī (1767) has the same epoch as Go shrī (1770), but has different *stong chen 'das lo*.[482]

PHUG VARIATION – *MKHAS PA'I SNYING NOR*

The *rtsis 'phro* values of the *Mkhas pa'i snying nor,* in the case that the epoch is 1987/3/0, are given. [483]

Table 21.

	tshes zla'i dkyil 'khor	*'khor grangs*	*rtsis 'phro*
gza'	39592	8657	37750
ril cha	3528	253	902
nyi ma	804	65	494

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481 For these values, see Bsam 'grub rgya mtsho (1992: 88). They are easily calculated in the same manner with those in the case of Sum pa Mkhan po.

482 See below p. 278.

483 Bsam 'grub rgya mtsho (1992: 81).

From the above table, the following values are calculated: *gza’ dhru’i ’phro*: 1^{z}39^{q}31'3"28"'103"", *ril cha’i ’phro* : 19/20, and *nyi’ dhru’i ’phro*: 25^{k}19^{q}15'1"23"', at 1987/3/0.[484]

PHUG VARIATION – *BYED MTHUN*

As the title indicates, the author Bsam gtan rgya mtsho tries to be maintain a system close to the *byed rtsis* on the basis of *Phug pa grub rtsis*. The *rtsis ’phro* values at 1987/3/0 are given. [485]

Table 22.

	tshes zla’i dkyil ’khor	*’khor grangs*	*rtsis ’phro*
gza’	39592	8657	9523
ril cha	3528	253	1683
nyi ma	804	65	123

The following values are calculated: *gza’ dhru’i ’phro*: 1^{z}46^{q}47'3"27"'6"", *ril cha’i ’phro* : 19/45, and *nyi’ dhru’i ’phro*: 25^{k}29^{q}19'4"14"' .[486]

Taken together, the *rtsis ’phro* values at 1987/3/0 are as follows:

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[484] For these values, see Bsam ’grub rgya mtsho (1992: 76-7). For the calculations of them, see the previous example of Sum pa Mkhan po.

[485] Bsam ’grub rgya mtsho (1992: 91).

[486] Bsam gtan rgya mtsho (2009: 377-8): *gza’ dhru’i ’phro* is given as 1/46/47/3/276. In it, 276 is incorrect. For these values, see also Bsam ’grub rgya mtsho (1992: 90-1). The epochs in Bsam gtan rgya mtsho (2009) and Bsam ’grub rgya mtsho (1992) are the same (= 1987/3/0).

Table 23.

	gza' dhru'i 'phro	*ril cha'i 'phro*	*nyi' dhru'i 'phro*
Pad dkar zhal lung ⓐ	$3^{z}11^{q}$27'2"31"'327""	21/90	0
Dga' ldan rtsis gsar ⓑ	$1^{z}42^{q}$9'2"34"'618""	19/92	$25^{k}19^{q}$15'1"23"'
Yang gsal sgron me ⓒ	$1^{z}41^{q}$40'4"44"'516""	20/13	$25^{k}9^{q}$10'4"32"'
Mkhas pa'i snying nor ⓓ	$1^{z}39^{q}$31'3"28"'103""	19/20	$25^{k}19^{q}$15'1"23"'
Byed mthun ⓔ	$1^{z}46^{q}$47'3"27"'6""	19/45	$25^{k}29^{q}$19'4"14"'

PHUG VARIATIONS – A COMPARISON: *GZA' BAR* / *RIL CHA* / *NYI BAR*

The following observations regarding the differences between *gza' bar*, *ril cha* and *nyi bar* among the three systems, *Pad dkar zhal lung*, *Dga' ldan rtsis gsar*, and *Mkhas pa'i snying nor*, are justified.

> *... zhal lung rjes 'brang nyi* (*sic.* read *nyin*) *snang sogs kyi dhru ba las dga' ldan rtsis gsar gyi dhru ba 'tshol na / 0/2/33/0/516*[487] *0/3 ri 'char* (*sic.* read *ril cha*) *0/30/13/40*[488] *'di byin pas 'char / rtsis gsar gyi dhru ba la de'i* (*sic.*) *phri bas zhal lung rjes 'brang dhru ba 'char zhal lung de gsum la gza' dhru / 262 ri 'char* (*sic.* read *ril cha*) */ 27 nyi dhru/ 0/0/5/4 0/69 0/29/76*[489] *'di rnams phri bas tho kan (sic.) snying nor gyi dhru ba 'char mkhas pa'i snying nor la de dag byin pas zhal lung gi dhru ba gza' dhru la / nyi dhru la / 'char ba yin no / de bzhin dge ldan rtsis gsar gyi gza' dhrur/ 0/2/37/5/71 ri la 'char* (*sic.* read *ril cha*) *0/72 'di dag phri bas snying nor 'char / snying nor gyi de*

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[487] This is either a typo or misreading. The correct value: $0^{z}2^{q}$32'0"516"' = $0^{z}2^{q}$32'0"48"'636"" after the *cha shas shed snyoms*. Also see Bsam 'grub rgya mtsho (1992: 87) for the value.

[488] This is either a typo or misreading. The correct value: $0^{k}30^{q}$13'2"40"' .

[489] These numbers were transcribed incorrectly. Also see Bsam 'grub rgya mtsho (1992: 81): *gza' dhru*: $0^{z}0^{q}$5'4"24"'586"", *ril cha*: 0/69, *nyi dhru*: $0^{k}26^{q}$29'46"3"'27"" .

gnyis snga ma de dag la byin na snying nor (*sic.* read *Dga' ldan rtsis gsar*) *gyi de gnyis 'char / nyi dhru ni snying nor dang rtsis gsar gcig pas bri snon med gsungs /*[490]

... If the *dhru ba*-s of the *Dga' ldan rtsis gsar* are found from the *dhru ba*-s of the *Nyin byed snang ba*, etc. which follow the *Pad dkar zhal lung*, [they] arise by adding [*gza' dhru*] $0^{z}2^{q}32'0''516'''$ (= $0^{z}2^{q}32'0''48'''636''''$), *ril cha* 0/3, *nyi dhru* $0^{k}30^{q}13'2''40'''$. By subtracting the amount from the *dhru ba*-s of the *Dga' ldan rtsis gsar*, the *dhru ba*-s of [the systems] following the *Pad dkar zhal lung* appear. By subtracting *gza' dhru* $0^{z}0^{q}5'4''24'''586''''$, *ril cha* 0/69, *nyi dhru* $0^{k}26^{q}29'46''3'''27''''$ from the three (*gza' dhru*, *ril cha*, *nyi dhru*) of the *Pad dkar zhal lung*, the *dhru ba*-s of Thu'u bkwan III's *Mkhas pa'i snying nor* appear. By adding the [three] values to [the three of] the *Mkhas pa'i snying nor*, the values of the *dhru ba*-s of the *Pad dkar zhal lung*, *gza' dhru*, [*ril cha*,] and *nyi dhru,* appear. Likewise, by subtracting *gza' dhru* $0^{z}2^{q}37'5''71'''$ (= $0^{z}2^{q}37'5''6'''515''''$), *ril cha* 0/72 from [the *gza' dhru* and *ril cha* values of] the *Dga' ldan rtsis gsar*, the values of *Mkhas pa'i snying nor* appear. If the two values of the *Mkhas pa'i snying nor* are added to the values of the former (= *Dga' ldan rtsis gsar*), the two values (*gza' dhru* and *ril cha*) of the *Dga' ldan rtsis gsar* appear. It is stated that, because the *nyi dhru* of *Mkhas pa'i snying nor* is the same with that of *Dga' ldan rtsis gsar*, there is no addition or subtraction.

To repeat the above passage,

Dga' ldan rtsis gsar – *Pad dkar zhal lung* : *gza' dhru* $0^{z}2^{q}32'0''516'''$ (= $0^{z}2^{q}32'0''48'''636''''$), *ril cha* 0/3, *and nyi dhru* $0^{k}30^{q}13'2''40'''$.

Pad dkar zhal lung – *Mkhas pa'i snying nor* : *gza' dhru* $0^{z}0^{q}5'4''24'''586''''$, *ril cha* 0/69, and *nyi dhru* $0^{k}26^{q}29'46''3'''27''''$.

Dga' ldan rtsis gsar – *Mkhas pa'i snying nor* : *gza' dhru* $0^{z}2^{q}37'5''71'''$ (= $0^{z}2^{q}37'5''6'''515''''$), *ril cha* 0/72, and *nyi dhru* $0^{k}0^{q}0'0''0'''$.

The values are verified in A kya's calculations below.

[490] Mi pham (2012a: 264-5).

PHUG VARIATIONS – A COMPARISON : A KYA BLO BZANG 'JAM DBYANGS RGYA MTSHO'S ECLIPSE CALCULATIONS: THE DIFFERENCES IN *GZA' DAG* / *NYI DAG* AND ECLIPSE CALCULATIONS.

A KYA'S CALCULATIONS AND OBSERVATIONS

A Kya serves as an example for demonstrating the differences between the *Pad dkar zhal lung* (*Phug pa grub rtsis*) and the *Dga' ldan rtsis gsar,* both of which belong to the *Phug* system. His is also one of the earlier writings in which the *Dga' ldan rtsis gsar* was used for real eclipse calculation. His calculations for the lunar eclipse at 1785 (*shing sbrul*)/12/15[491] are as follows:

Phug pa grub rtsis: *gza' dag* $0^{z}21^{q}36'2''29'''505''''$, *nyi dag* $19^{k}48^{q}41'3''57'''$, *sgra gcan rtsa* $5^{k}55^{q}41'4''10'''$, *sgra gcan gdong* $21^{k}4^{q}18'1''13'''$, and *sgra gcan mjug* $7^{k}34^{q}18'1''13'''$.

[491] See A kya (2000: 3b). The dates in each tradition are as follows:

Gregorian date	Jan, 14, 1786
grub rtsis	1785 (T. *shing sbrul*)/12/15
byed rtsis	1785/12/15
dga' ldan rtsis gsar	1785/12/15
Chinese lunar date	1785/12/15

The following *mda' ro lhag ma*-s are used for the determination of leap moth: 48, 49 for the *Phug pa grub rtsis*, 63, 64 for the *byed rtsis*, and 46, 47 for the *Dga' ldan rtsis gsar* indicate leap months. In other words, 50, 51 for *Phug pa grub rtsis*, 65, 66 for *byed rtsis*, 48, 49 for *Dga' ldan rtsis gsar* are the *mda' ro lhag ma*-s of the leap months.

Dga' ldan rtsis gsar : *gza' dag* $0^{z}25^{q}27'4''13'''232''''$[492], *nyi dag* $20^{k}20^{q}15'4''2'''$, *sgra gcan rtsa* $6^{k}2^{q}44'2''2'''$, *sgra gcan gdong* $20^{k}57^{q}15'3''21'''$, and *sgra gcan mjug* $7^{k}27^{q}15'3''21'''$.

byed rtsis: *gza' dag* $0^{z}8^{q}0'5''2'''$, and *nyi dag* : $20^{k}31^{q}28'1''3'''$[493] . *sgra gcan* values: not given.

A kya's calculations for the solar eclipse of 1785/12/30[494] are as follows:

Phug pa grub rtsis: *gza' dag* $1^{z}59^{q}26'0''36'''324''''$, *nyi dag* $20^{k}57^{q}5'2''16'''$, *sgra gcan rtsa* $5^{k}59^{q}13'0''6'''$, *gdong* $21^{k}0^{q}46'5''17'''$, and *mjug* $7^{k}30^{q}46'5''17'''$.

Dga' ldan rtsis gsar: *gza' dag* $2^{z}3^{q}17'2''19'''51''''$, *nyi dag* $21^{k}28^{q}39'5''28'''$[495], *sgra gcan rtsa* $6^{k}6^{q}15'2''21'''$[496], *gdong* $20^{k}53^{q}44'3''2'''$[497], and *mjug* $7^{k}23^{q}44'3''2'''$[498] .

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[492] Since it is not likely that A kya was mistaken in the calculation, this seems to be a scribal error. The correct quantity is $0^{z}25^{q}27'4''12'''232''''$.

[493] Given A kya's table, there are hitherto unknown calculations named *gsar spel byed pa* and *gsar spel grub rtsis.* Interestingly, the quantity entered in the section of *gsar spel byed pa* in the table given by A kya is that of the commonly used *byed rtsis* (m = 2 in Schuh's (1973a) notation). I propose that *gsar spel grub pa* may be the tradition in which the *rtsis 'phro* values changed from the generally known *grub rtsis*. Further research is needed.

[494] See A kya (2000a: 6b [= 47 *ben* (本) *xia* (下) 5]). The dates in each tradition are as follows:

Gregorian date	Jan 29, 1786	Jan 30, 1786
grub rtsis	1785 (T. *shing sbrul*)/12/29	1786 (T. *me rta*)/1/1
byed rtsis	1785/12/30	1786/1/1
dga' ldan rtsis gsar	1785/12/29	1785/12/30
Chinese lunar date	1785 (Ch. *yisi* 乙巳)/12/30	1786 (Ch. *bingwu* 丙午)/1/1

[495] This seems to be a scribal error. The correct value is $21^{k}28^{q}39'2''28'''$.

[496] This seems to be a scribal error. The correct value is $6^{k}6^{q}15'3''21'''$.

[497] This seems to be a scribal error. The correct value is $20^{k}53^{q}44'2''2'''$.

byed rtsis : gza' dag $1^z45^q39'0"5'''$ *and nyi dag* $21^k39^q52'0"5'''$, *sgra gcan* is not given.

VERIFICATION OF A KYA'S CALCULATIONS

Calculation # 1. *Phug pa grub rtsis* at 1785/12/15

Epoch data at 1687/3/0 in the case of *Phug pa grub rtsis*

I use the Sde srid's *Vaiḍūrya dkar po,* whose epoch is 1687/3/0: *zla dag*: 0/15 (1/65), *gza' dhru'i 'phro*: $0^z10^q57'2"692'''$ (707), *ril cha'i 'phro*: 18/33 (28/126), *nyi dhru'i 'phro*: $26^k29^q46'3"27'''$ (67), and Rāhu: 209.[499]

1. *zla dag*: 1221, *mda' ro lhag ma*: 45[500]

$1785 - 1687 = 98$

$12 - 3 = 9$

$(98 \times 12 + 9) + 36 = \mathbf{1221}$: ***zla dag***

$(98 \times 12 + 9) \times 2 + 15^{501} = 2385$

$\frac{2385}{65} = 36$...... **45:** ***mda' ro lhag ma***

2. *gza' dhru*: $0^z1^q45'3"669'''$[502]

$\frac{(1221 \times 1 + 0 + 648)}{7} = 267$ **0**

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[498] This seems to be a scribal error. The correct value is $7^k23^q44'2"2'''$.

[499] For the epoch value, see Sde srid (1996: 30) and Henning (2013). The *Lnga bsdus* values of the *grub rtsis* by Grwa phug pa, Dharmaśrī, Sde srid, and Phyag mdzod are the same. They are all based upon the *Pad dkar zhal lung* and any of these values can be used in this case. According to Schuh's classification, this case is m = 1A. See Schuh (1973a), Schuh (2012a).

[500] True month (*zla dag*) is the number of lunar months past.

[501] 15 is residual (*'phro*) from the the previous *rab byung.*

[502] The mean weekday value (*gza' dhru'i 'phro*): $0^z10^q57'2"692'''$ (707) is the *gza' bar* value at epoch. The *gza' dhru 'phro* and *nyi dhru 'phro* values are the same within a month, representing the time of mean conjunction at epoch.

$$\frac{(1221 \times 31 + 10 + 1020)}{60} = 648 \ldots\ldots \mathbf{1}$$
$$\frac{(1221 \times 50 + 57 + 138)}{60} = 1020 \ldots\ldots \mathbf{45}$$
$$\frac{(1221 \times 0 + 2 + 829)}{6} = 138 \ldots\ldots \mathbf{3}$$
$$\frac{(1221 \times 480 + 692)}{707} = 829 \ldots\ldots \mathbf{669}$$

3. *ril cha: ril bo* 5 / *cha shas* 120[503]

$$\frac{(1221 \times 2 + 18 + 9)}{28} = 88 \ldots\ldots \mathbf{5}$$
$$\frac{(1221 \times 1 + 33)}{126} = 9 \ldots\ldots \mathbf{120}$$

4. *nyi dhru:* $18^k44^q19'4''14'''$[504]

$$\frac{(1221 \times 2 + 26 + 223)}{27} = 99 \ldots\ldots \mathbf{18}$$
$$\frac{(1221 \times 10 + 29 + 1185)}{60} = 223 \ldots\ldots \mathbf{44}$$
$$\frac{(1221 \times 58 + 46 + 255)}{60} = 1185 \ldots\ldots \mathbf{19}$$
$$\frac{(1221 \times 1 + 3 + 310)}{6} = 255 \ldots\ldots \mathbf{4}$$
$$\frac{(1221 \times 17 + 27)}{67} = 310 \ldots\ldots \mathbf{14}$$

5. *gza' bar:* $0^z47^q40'4''202'''$[505]

There are two methods: 1) search for the 15th day value in the table of *grub rtsis kyi gza'i rtag longs* or 2) find the daily mean motion of the moon $0^z59^q3'4''16\ (707) \times 15 = 0^z45^q55'0''240'''$. The results are the same.
gza' bar: $0^z45^q55'0''240'''$ + *gza' dhru* $0^z1^q45'3''669'''$ $=$ $0^z47^q40'4''202'''$.

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[503] Its unit is *tshes pa.* See Ōhashi (1997: 137): "Since the period of 28 *tshes zhag* is a little longer than the actual anomalistic month, a special correction is also applied so as to diminish the period of 28 *tshes zhag* at the rate of one *tshes zhag* per 3780 *tshes zhag.*" One lunar step (*zla rkang*) is divided into 3780 subtle lunar steps (*zla rkang cha shas*), one lunar step = 126 fractional lunar steps (*ril bo cha shas*), and one fractional lunar step = 30 subtle lunar steps. In other words, 126 × 30 = 3780.

[504] $2^k10^q58'1''17'''$ = the mean motion of the Sun per one lunar month (*grub rtsis*). $0^k4^q21'5''43'''$ = the sun's mean movement per lunar day. *Nyi dhru'i 'phro* $26^k29^q46'3''27'''$ (67) = the sun's distance to vernal equinox at epoch. *Nyi dhru* $18^k44^q19'4''14'''$ means that the sun is $44^q19'4''14'''$ away from the 18th constellation *mūla* (T. *snrubs*) at 1785/12/0.

[505] The approximate weekday for 1785/12/15 is Saturday (see 0 in the *gza' gnas*). It is calculated by the mean motion of the moon.

6. *nyi bar*: 19^{k}49^{q}48'4"56"'[506]

There are two methods: 1) search the 15th day value in the table of *grub rtsis kyi nyi ma'i rtag longs* or 2) the daily mean motion of the sun 0^{k}4^{q}21'5"43 (67) × 15 = 1^{k}5^{q}29'0"42 (67). The results are the same.

nyi bar: 1^{k}5^{q}29'0"42 (67) + *nyi dhru* 18^{k}44^{q}19'4"14"' = 19^{k}49^{q}48'4"56"' (27/60/60/6/67)

***7. gza' phyed dag pa*: 0^{z}22^{q}43'3"303"' [= 0^{z}22^{q}43'3"28"'505""** (the value after the *cha shas shed snyoms* has been applied)**]**

$$\frac{15\ (\text{tshes pa}) + 5\ (\text{ril bo})}{14} = 1$$[507]

Table 24.

	step index (*rkang 'dzin/ rkang bzung*)	multiplier (*sgyur byed*)[508]	step total (*rkang sdom*)
early step (*snga rkang*)	1	5	5
	2	5	10
	3	5	15
	4	4	19
	5	3	22
	6	2	24
	7	1	25[509]

[506] 19^{k}49^{q}48'4"56"' means that the mean sun is 49^{q}48'4"56"' away from the 19th constellation *chu stod* (*pūrvāṣāḍhā*) at 1785/12/15.

[507] 1: odd number. Therefore, it is unequal and is subtracted later.

[508] The *gza'i rtag longs* (*tshes zhag.* the daily mean motion of the moon) in both *Phug pa grub rtsis* and *byed rtsis* is around 0^{z}59^{q}3'4"16"'. If + 5 ~ − 5 are added to this value, the *tshes zhag* approximately ranges from 54^q~ 64^q. The *grub rtsis* and *byed rtsis* show little difference in value. See the table in pp. 196-8. For further information, see Yamaguchi (1974: 85-7) and Ōhashi (1984: 32-5).

[509] The *Kālacakratantra* emerged far later than the *Sūryasiddhānta*, one of the Indic astronomical texts in which the geometric method was used and which was already well established. — For the equation of the center in the *Sūryasiddhānta,* see van Wijk's classical study (1923: 206-23), (1924: 55-62). — Strangely, the *Kālacakratantra* is based upon this arithmetic method for the motion of the sun and moon. Therefore, it may be reasonable to argue that even if the geometric model on which this table is based cannot be pinpointed, it is based upon a geometric model. In fact, modern scholars have pointed out various possible opinions. Schuh (1973a: 124-6) shows that the equation of the center of the Moon is presented in terms of nearly exact sine functions. See Ōhashi (1986: 635-7, 643). Also see Ōhashi (1997: 137): "These values were probably originally meant to be the difference between the mean motion and the true motion of the moon during one *tshes zhag* in terms of *chu tshod.* ... The maximum equation is the total of the variables, that is 25 *chu tshod* or 5°23'20"." Huang and Chen's (1987: 150-1) calculation is 5˚56.

Table 24 (continued)

later step (*phyi rkang*)	8	1	24
	9	2	22
	10	3	19
	11	4	15
	12	5	10
	13	5	5
	0	5	0

In case that *rkang bzung* is 6 and *rkang sdom* is **24**, the *sgyur byed* is 1. Multiply it by *ril bo cha shas* (in this case 120) and then divide the result by 126.

$\frac{1 \times 120 \text{ (ril bo cha shas)}}{126} = \mathbf{0}$ *yang dag rgyu ba'i dus kyi chu tshod ......* 120

$\frac{120 \times 60}{126} = \mathbf{57}$ *yang dag rgyu' ba'i dus kyi chu srang ......* 18

$\frac{18 \times 6}{126} = \mathbf{0}$ *yang dag rgyu' ba'i dus kyi dbugs ......* 108

$\frac{108 \times 707}{126} = \mathbf{606}$ *...... yang dag rgyu' ba'i dus kyi cha shas*

In the case of *snga rkang*, the *rkang sdom* is added to *yang dag rgyu ba'i chu tshod*. In the case of *phyi rkang*, the *rkang sdom* is subtracted from *yang dag rgyu ba'i chu tshod*. In this case, **24** (*rkang sdom*) + 0 = *24* is the final *yang dag rgyu ba'i chu tshod*. Hece, *zla rkang*: **24** (*yang dag rgyu ba'i chu tshod*)/ **57** (*yang rgyu' srang*)/ **0** (*dbugs*)/ **606** (*cha shas*).

1 is odd number. Therefore, it is unequal and is subtracted from *gza' bar*, i.e. *gza' bar* 0^{z}47^{q}40'4"202"' (7/60/60/6/707) – 0^{z}24^{q}57'0"606"' = 0^{z}22^{q}43'3"303"': *gza' phyed dag pa* [= **0^{z}22^{q}43'3"28"'505""** (*cha shas shed snyoms*)].

8. *nyi dag*: 19^{k}48^{q}41'3"57"'

nyi bar: 19^{k}49^{q}48'4"56"' *(27/60/60/6/67)*
– 6^{k}45^{q}
13^{k}4^{q}48'4"56"'
13^{k}4^{q} = 784^{q}
$\frac{784q}{135}$ = 5 *khyim ......* 109^{q}
-> *ma dor (mi dor)*: non-deductible.

Table 25: The table of the step index of the sun.[510]

	step index (*rkang 'dzin/ rkang bzung*)	multiplier (*sgyur byed*)	step total (*rkang sdom*)
early step (*snga rkang*)	0	6	0
	1	4	6
	2	1	10
later step (*phyi rkang*)	3	1	11[511]
	4	4	10
	5	**6**	**6**

In this case, the *sgyur byed* is 6 and the *rkang sdom* is 6**.**
$109^q \times 6 = 654^q$

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[510] The *nyi ma'i rtag longs* (*tshes zhag*) in both *Phug pa grub rtsis* and *byed rtsis* are approximately $0^k4^q21'5''$ (truncated value). The *grub rtsis* and *byed rtsis* show little difference in value. See the table in pp. 196-8. The corrected value is approximately $0^k4^q10'$ ~ $0^k4^q33'$. For more information, see Yamaguchi (1974: 86) and Ōhashi (1984: 30-2). The table of the movement of the true sun on the basis of the *Kālacakra* / *skar rtsis* is as follows:

		khyim	*sgyur byed*	corrected value (approximate value)
rim pa	early step (*snga rkang*)	*karka ṭa (apogee)*	6	$0^k4^q21'5''-11'3'' \approx 0^k4^q10'$
		seng ge	4	$0^k4^q21'5''- 7'4'' \approx 0^k4^q14'$
		bu mo	1	$0^k4^q21'5'' - 1'5'' \approx 0^k4^q20'$
	later step (*phyi rkang*)	*srang*	1	$0^k4^q21'5''+ 1'5'' \approx 0^k4^q23'$
		sdig	4	$0^k4^q21'5''+ 7'4'' \approx 0^k4^q29'$
		gzhu	6	$0^k4^q21'5'' + 11'3'' \approx 0^k4^q33'$
rim min	early step	*chu srin (perigee)*	6	$0^k4^q21'5'' + 11'3'' \approx 0^k4^q33'$
		bum pa	4	$0^k4^q21'5'' + 7'4'' \approx 0^k4^q29'$
		nya	1	$0^k4^q21'5'' + 1'5'' \approx 0^k4^q23'$
	later step	*lug*	1	$0^k4^q21'5'' - 1'5'' \approx 0^k4^q20'$
		glang	4	$0^k4^q21'5'' - 7'4'' \approx 0^k4^q14'$
		'khrig	6	$0^k4^q21'5'' - 11'3'' \approx 0^k4^q10'$

[511] Schuh (1973a: 126-30) shows that the "equation of the center" of the Sun is presented in terms of nearly exact sine functions. Huang and Chen's calculation (1987: 154-5) for the maximum equation of the sun is 2°44. Ōhashi (1997: 137): "This *dal rkang* is, in fact, the difference between the mean motion and the true motion of the sun during one zodiacal sign's movement of the mean sun in terms of *chu tshod*." Ōhashi (1997) maintains that the *dal rkang* is "equation of the center" and the *myur rkang* is "epicyclic correction." See also Ōhashi (1986: 635-6, 643). — This is contoversial. For example, Petri (1967: 160): "Fairly clear are the tables of *śīghra* (T. *myur ba*) and *manda* (T. *dal ba*) corrections of the mean motion of the planets, which correspond to the first epicycle and the displacement due to eccentricity." — Ōhashi's calculation value for the 11 *chu tshod* ($= 6 + 4 + 1$) ($=$ maximum equation of the sun) is 2°26'40". Sivin's explanation of the phase of expansion/contraction may help to understand this context even if it is for Yuan period Chinese astronomy. See Sivin (2009: 411-2).

$\frac{654q}{135} = \mathbf{4}$ ...... 114 *yang dag rgyu ba'i yul gyi chu tshod*
$\frac{48 \times 6 + 114 \times 60}{135} = \frac{7128}{135} = \mathbf{52}$ ...... 108 *yang dag rgyu' ba'i yul gyi chu srang*
$\frac{4 \times 6 + 108 \times 6}{135} = \frac{672}{135} = \mathbf{4}$ ...... 132 *yang dag rgyu' ba'i yul gyi dbugs*
$\frac{56 \times 6 + 132 \times 67}{135} = \mathbf{68}$ ...... 0 *yang dag rgyu' ba'i yul gyi cha shas*
$6\ (= 5^q59'5''67''') -$ *nyi rkang* **4^{q}52'4"68"'** $= 1^q7'0''66'''$

In the case of *snga rkang*, the *nyi rkang* is added to the *rkang sdom*. For the case of ***phyi rkang***, substract the *nyi rkang* from the *rkang sdom*.
$- 1^q7'0''66''' + 19^k49^q48'4''56''' =$ **19^{k}48^{q}41'3"57"': *nyi dag***

9. *gza' dag*: 0^{z}21^{q}36'2"29"'505"" [512]
gza' phyed dag pa $0^z22^q43'3''28'''505'''' - 1^q7'0''66''' =$ **0^{z}21^{q}36'2"29"'505"": *gza' dag***

10. *tshes 'khyud zla skar*: 6^{k}18^{q}41'3"57"' [513]
$19^k48^q41'3''57''' + 13^k30^q =$ **6^{k}18^{q}41'3"57"' (67)**

11. *sgra gcan rtsa* 5^{k}55^{q}41'4"10"', *sgra gcan gdong* 21^{k}4^{q}18'1"13"', *sgra gcan mjug* 7^{k}34^{q}18'1"13"'
$\frac{(1221 + 209)}{230} = 6$ 50
$50 \times 30 + 15 = 1515$
$1515 \times 0^k0^q14'0''12''' =$ **5^{k}55^{q}41'4"10"' (23): *sgra gcan rtsa***
$1515 \times 0 + 5 = \mathbf{5}$
$\frac{1515 \times 0 + 355}{60} = 5$ **55**
$\frac{1515 \times 14 + 131}{60} = 355$ **41**
$\frac{1515 \times 0 + 790}{6} = 131$ **4**
$\frac{1515 \times 12}{23} = 790$ **10**
$27 - 5^k55^q41'4''10''' =$ **21^{k}4^{q}18'1"13"'** : ***sgra gcan gdong***
$13^k30^q + 21^k4^q18'1''13''' =$ **7^{k}34^{q}18'1"13"'** : ***sgra gcan mjug***

Calculation #2. *Phug pa grub rtsis* at 1785/12/29[514]

[512] It is Saturday (see the *gza' gnas*), which spans $21^q36'2''29'''505''''$

[513] Janson (2014: 29): "the true longitude of the moon at the end of the lunar day (*tshes zhag*)."

[514] In the case of *grub rtsis*, 1785/12/28 is doubled (T. *lhag*) and 1785/12/30 does not exist (T. *chad*). 1785/12/29 is followed by 1786/1/1. *Chad* is a troublesome situation for eclipse calculations. The general interpretation is that, for the real occurrence of an eclipse, the day-reckoning based upon the *lhag chad* according to *grub rtsis* works better than that based upon the *lhag chad* according to *byed rtsis*. For example, Nor bzang rgya mtsho is critical for *byed rtsis* from that view: Nor bzang rgya mtsho (2002a: 587): "because

Epoch Data at 1687/3/0 in the case of *Phug pa grub rtsis*

zla dag: 0/15 (1/65), *gza' bar*: $0^{z}10^{q}$57'2"692"'(707), *ril cha*: 18/33 (28/126), *nyi bar*: $26^{k}29^{q}$46'3"27"'(67), and Rāhu: 209.

Table 26.

1. *zla dag*: 1221, *mda' ro lhag ma*: 45[515]	2. *gza' dhru*: $0^{z}1^{q}$45'3"669"'	3. *ril cha*: 5/120
$1785 - 1687 = 98$ $12 - 3 = 9$ $(98 \times 12 + 9) + 36 = \mathbf{1221}$: *zla dag* $(98 \times 12 + 9) \times 2 + 15 = 2385$ $\frac{2385}{65} = 36 \ldots\ldots \mathbf{45}$: *mda' ro lhag ma*	$\frac{(1221 \times 1 + 0 + 648)}{7} = 267 \ldots\ldots \mathbf{0}$ $\frac{(1221 \times 31 + 10 + 1020)}{60} = 648 \ldots\ldots \mathbf{1}$ $\frac{(1221 \times 50 + 57 + 138)}{60} = 1020 \ldots\ldots \mathbf{45}$ $\frac{(1221 \times 0 + 2 + 829)}{6} = 138 \ldots\ldots \mathbf{3}$ $\frac{(1221 \times 480 + 692)}{707} = 829 \ldots\ldots \mathbf{669}$	$\frac{(1221 \times 2 + 18 + 9)}{28} = 88 \ldots\ldots \mathbf{5}$ $\frac{(1221 \times 1 + 33)}{126} = 9 \ldots\ldots \mathbf{120}$

according to the value by the practice of the *byed rtsis*, it is possible that solar and lunar eclipse occur on the first day and on the sixteenth day [respectively] … ." (*… byed pa'i da lta'i lag len gyi ri mo la / nyi zla gza' 'dzin tshes gcig dang bcu drug la 'ong ba'i skabs srid kyi 'dugs pas / … .*). A solar eclipse is believed to occur on the 30th and a lunar eclipse is on the 15th, according to the *skar rtsis* calculations. Dkon mchog 'phrin las bzang po (1975: 53b): "An eclipse occurs even if there are *lhag chad* in *byed rtsis.* Especially, when the thirtieth day (new moon day) is *chad*, a solar eclipse is seen on the [following] first day. Because, if the full moon and new moon days are *chad,* according to *grub rtsis*, the moon and sun are not eclipsed [respectively]. Therefore, the *lhag chad* of day should be investigated in detail, … . " (*byed rtsis lhag chad yod kyang 'dzin / khyad par nam gang chad pa'i tshe / tshes gcig la ni 'dzin par mthong / grub mtha' rtsis la nya stong dag / chad na nyi zla mi 'dzin pas / de phyir tshes kyi chad lhag sogs / zhib mor dpyad de … .*). Also see Phyag mdzod [= Huang and Chen (1987: 36-7): "It is said that if the full moon and new moon days are *chad* according to *grub rtsis*, the moon and sun are not eclipsed [respectively], but in some cases among those that full moon and new moon days are *chad*, the occurrences of the eclipse are seen in a *myong byang* (note of observation / experience). … Except for some (= such) cases, it is known to be unmistaken by this method [of eclipse calculation]." (*grub pa'i nya stong tshes chad na / zla nyi 'dzin par mi 'gyur zhes / bshad kyang nya stong chad pa 'gar / gza' 'dzin byung ba'i myong byang mthong / … de 'dra'i 'ga' re ma gtogs pa / cho ga 'dis yis 'khrul med shes /*). Phyag mdzod presents two exceptions: a solar eclipse at 1814/5/30 and a lunar eclipse at 1823/8/22. For more information regarding this passage, see also Henning (2007: 139). Overall, Tibetan astronomers believe that *lhag chad* in the *grub rtsis* system is more reliable and an eclipse rarely occurs on the occasion of the *chad* in the *grub rtsis* system. Here, in A kya's calculations, 1785/12/30 is *chad* according to *grub rtsis* for the calculation of the solar eclipse. In other words, this case opposes the general belief of most Tibetan astronomers, including Nor bzang rgya mtsho and Dkon mchog 'phrin las bzang po, etc.. In addition, A kya's calculations show how eclipse calculations are made in such cases that a day is *chad*. He supposes that a day 30 exists in this case and then calculates such things as *nyi dag* and *gza' dag* for that day 30. See his calculations below. More various cases pertaining to the exegeses on the *lhag chad* in the case of eclipse calculation and real calculation methods in the case of *lhag chad* are expected to be collected in future research.

[515] Read the calculations from left to right and from top to bottom.

Table 26 (continued)

4. ***nyi dhru:*** $18^{k}44^{q}19'4''14'''$ $\frac{(1221\times 2+26+223)}{27}=99$ ...... **18** $\frac{(1221\times 10+29+1185)}{60}=223$ ...... **44** $\frac{(1221\times 58+46+255)}{60}=1185$ ...... **19** $\frac{(1221\times 1+3+310)}{6}=255$ ...... **4** $\frac{(1221\times 17+27)}{67}=310$ **14**	5. ***gza' bar:*** $1^{z}33^{q}35'4''442'''$ Two methods: 1) search for the 30th day value in the table of *grub rtsis kyi gza'i rtag longs.* 2) $0^{z}59^{q}3'4''16$ (707) $\times$ 30 = $1^{z}31^{q}50'0''480'''$. The results are the same. *gza' bar*: $1^{z}31^{q}50'0''480'''$ + *gza' dhru* $0^{z}1^{q}45'3''669'''$ = **$1^{z}33^{q}35'4''442'''$** (7/60/60/6/707).	6. ***nyi bar:*** $20^{k}55^{q}17'5''31'''$ Two methods: 1) search for the 30th day value in the table of *grub rtsis kyi nyi ma'i rtag longs.* 2) $0^{k}4^{q}21'5''43$ (67) $\times$ 30 = $2^{k}10^{q}58'1''17$ (67). The results are the same. *nyi bar*: $2^{k}10^{q}58'1''17$ (67) + *nyi dhru* $18^{k}44^{q}19'4''14'''$ = **$20^{k}55^{q}17'5''31'''$** (27/60/60/6/67)
7. ***gza' phyed dag pa:*** $1^{z}57^{q}38'3''543'''$ [= $1^{z}57^{q}38'3''51'''324''''$ (*cha shas shed snyoms*)] $\frac{30 \text{ (tshes pa)} + 5 \text{ (ril bo)}}{14} = 2$ ..... 7 . 2 is an even number. Therefore, it is equal and is later added to *gza' bar* later. In the case that the step index is 7, the *rkang sdom* is 25 and the *sgyur byed* is 1. Multiply 1 by *ril bo cha shas* (in this case 120) and divide by 126. $\frac{1\times 120}{126}$ = *yang dag rgyu' ba'i dus kyi chu tshod* ...... *120* $\frac{120\times 60}{126}$ = **57** *yang dag rgyu' ba'i dus kyi chu srang* ...... 18 $\frac{18\times 6}{126}$ = **0** *yang dag rgyu' ba'i dus kyi dbugs* ...... 108 $\frac{108\times 707}{126}$ = **606** ...... *yang dag rgyu' ba'i dus kyi cha shas* In the case of *phyi rkang* (later step), the *rkang sdom* is subtracted from the *yang dag rgyu' chu tshod.* In this case, *rkang sdom* is 25. Therefore, 25 − **$0^{q}57'0''606'''$** = $24^{q}2'5''101'''$. 2 is an even number. Therefore, it is equal and is added to *gza' bar.* *gza' bar* $1^{z}33^{q}35'4''442'''$(7/60/60/6/707) + $0^{z}24^{q}2'5''101'''$ = ***gza' phyed dag pa:*** **$1^{z}57^{q}38'3''543'''$** = **$1^{z}57^{q}38'3''51'''324''''$ (*cha shas shed snyoms*)**	8. ***nyi dag:*** **$20^{k}57^{q}5'2''16'''$** *nyi bar:* $20^{k}55^{q}17'5''31'''$ (27/60/60/6/67) $-\,6^{k}45^{q}$ $14^{k}10^{q}17'5''31'''$ *dor:* deductible. $-\,13^{k}30^{q}$ $0^{k}40^{q}17'5''31'''$ $\frac{40q}{135}$ = 0 *khyim* ...... 40^{q} *sgyur byed* index: 6 -> *rkang sdom* step total: 0 $\frac{40\times 6}{135}$ = **1** ...... 105 *yang dag rgyu ba'i yul gyi chu tshod* $\frac{17\times 6+105\times 60}{135}=\frac{6402}{135}$ = **47** ...... 57 *yang dag rgyu' ba'i yul gyi chu srang* $\frac{5\times 6+57\times 6}{135}$ = **2** ...... 102 *yang dag rgyu' ba'i yul gyi dbugs* $\frac{31\times 6+102\times 67}{135}$ = **52** ...... 0 *yang dag rgyu' ba'i yul gyi cha shas* **$1^{q}47'2''52'''$** + 0 + $20^{k}55^{q}17'5''31'''$ = **$20^{k}57^{q}5'2''16'''$** ***: nyi dag*** If it is *snga rkang* (early step), add.	9. ***gza' dag:*** $1^{z}59^{q}26'0''36'''324''''$ *gza' phyed dag pa* $1^{z}57^{q}38'3''51'''324''''$ + $1^{q}47'2''52'''$ + 0 = **$1^{z}59^{q}26'0''36'''324''''$** ***: gza' dag***

Table 27. ***Sgra gcan* Values**

sgra gcan rtsa $5^k59^q13'0''6'''$ $\frac{(1221+209)}{230} = 6 \ldots\ldots 50$ $50 \times 30 + 30 = 1530$ $1530 \times 0/0/14/0/12 = \mathbf{5^k59^q13'0''6'''}$ (27/60/60/6/23) $\frac{1530 \times 0 + 5}{27} = \mathbf{5}$ $\frac{1530 \times 0 + 359}{60} = 5 \ldots\ldots \mathbf{59}$ $\frac{1530 \times 14 + 133}{60} = 359 \ldots\ldots \mathbf{13}$ $\frac{1530 \times 0 + 798}{6} = 133 \ldots\ldots \mathbf{0}$ $\frac{1530 \times 12}{23} = 798 \ldots\ldots \mathbf{6}$	*sgra gcan gdong* $21^k0^q46'5''17'''$, *sgra gcan mjug* $7^k30^q46'5''17'''$ $27 - 5^k59^q13'0''6''' = \mathbf{21^k0^q46'5''17'''}$ $13^k30^q + 21^k0^q46'5''17''' = \mathbf{7^k30^q46'5''17'''}$
gdong $21^k0^q46'5''17''' - 0^k31^q41'4''10(23)$ [516] $= 20^k29^q5'1''7'''$ --> corrected *gdong* value. *mjug* $7^k30^q46'5''17''' - 0^k31^q41'4''10(23) = 6^k59^q5'1''7'''$ --> corrected *mjug* value. Compare them with *nyi dag* $20^k57^q5'2''16'''$.	

Calculation #3. Sum pa Mkhan po's *Dga' ldan rtsis gsar* 1785/12/15

Epoch data at 1747/3/0 in the case of *Dga' ldan rtsis gsar*

True month: 0/10 (1/65), *gza' dhru'i 'phro*: $1^z55^q13'3''333''' = 1^z55^q13'3''31'''394''''$ (67/707), *ril /cha*: 24/22 (28/126), *nyi dhru'i 'phro*: $26^k39^q51'0''18'''$(67), Rāhu: 32.[517] .

[516] For this *nur ster*/ *nur phri* method, see above pp. 197-203.

[517] For the epoch value, see Henning (2013). According to Schuh's (1973a/2012) classification, this case is m = 10.

Table 28.

1. *zla dag*: 479, *mda' ro lhag ma*: 30 $1785 - 1747 = 38$ $12 - 3 = 9$ $(38 \times 12 + 9) + 14 = 465 + 14$ $= \mathbf{479}$: *zla dag* $(38 \times 12 + 9) \times 2 + 10 = 940$ $\frac{940}{65} = 14 \ldots\ldots \mathbf{30}$: *mda' ro lhag ma*	**2. *gza' dhru*: $0^{z}4^{q}17'4''478'''$** $\frac{(479 \times 1 + 1 + 255)}{7} = 105 \ldots\ldots \mathbf{0}$ $\frac{(479 \times 31 + 55 + 400)}{60} = 255 \ldots\ldots \mathbf{4}$ $\frac{(479 \times 50 + 13 + 54)}{60} = 400 \ldots\ldots \mathbf{17}$ $\frac{(479 \times 0 + 3 + 325)}{6} = 54 \ldots\ldots \mathbf{4}$ $\frac{(479 \times 480 + 333)}{707} = 325 \ldots\ldots \mathbf{478}$	**3. *ril cha*: 5/123** $\frac{(479 \times 2 + 24 + 3)}{28} = 35 \ldots\ldots \mathbf{5}$ $\frac{(479 \times 1 + 22)}{126} = 3 \ldots\ldots \mathbf{123}$
4. *nyi dhru*: $19^{k}14^{q}33'0''54'''$[518] $\frac{(479 \times 2 + 26 + 88)}{27} = 39 \ldots\ldots \mathbf{19}$ $\frac{(479 \times 10 + 39 + 465)}{60} = 88 \ldots\ldots \mathbf{14}$ $\frac{(479 \times 58 + 51 + 100)}{60} = 465 \ldots\ldots \mathbf{33}$ $\frac{(479 \times 1 + 0 + 121)}{6} = 100 \ldots\ldots \mathbf{0}$ $\frac{(479 \times 17 + 18)}{67} = 121 \ldots\ldots \mathbf{54}$	**5. *gza' bar*: $0^{z}50^{q}12'5''11'''$** Two methods: 1) search the 15th day value in the table of *grub rtsis kyi gza'i rtag longs*. 2) $0^{z}59^{q}3'4''16$ (707) $\times$ 15 $=$ $0^{z}45^{q}55'0''240'''$. The results are the same. $0^{z}45^{q}55'0''240'''$ + *gza' dhru* $0^{z}4^{q}17'4''478'''$ = $\mathbf{0^{z}50^{q}12'5''11'''}$ (7/60/60/6/707).	**6. *nyi bar*: $20^{k}20^{q}2'1''29'''$** Two methods: 1) search the 15th day value in the table of *grub rtsis kyi nyi ma'i rtag longs*. 2) $0^{k}4^{q}21'5''43'''$ (67) [519] $\times$ 15 $=$ $1^{k}5^{q}29'0''42$ (67). The results are the same. $1^{k}5^{q}29'0''42'''$ (67) + *nyi dhru* $19^{k}14^{q}33'0''54'''$ = $\mathbf{20^{k}20^{q}2'1''29'''}$ (27/60/60/6/67)

[518] As seen above, in the case of Sum pa Mkhan po's *Dga' ldan rtsis gsar*, the *nyi ma'i rtag longs* of a month (T. *tshes zla*) is $2^{k}10^{q}58'1''17'''$(67). Schuh's value $2^{k}10^{q}58'2''500'''$(707) is incorrect; see Schuh (2012a: 120).

[519] As seen above, in the case of Sum pa Mkhan po's *Dga' ldan rtsis gsar*, the *nyi ma'i rtag longs* of a day (T. *tshes zhag*) $0^{k}4^{q}21'5''43'''$(67). Schuh's value $0^{k}4^{q}21'5''488'''$(707) is incorrect; see Schuh (2012a: 120).

Table 28 (continued)

7. *gza' phyed dag pa:* $0^{z}25^{q}14'1''415''$[$0^{z}25^{q}14'1''39'''232''''$ (*cha shas shed snyoms*)]	**8. *nyi dag*:** $20^{k}20^{q}15'4''2'''$	**9. *gza' dag*:** $0^{z}25^{q}27'4''12'''232''''$
$\frac{(15+5)}{14} = 1$ ...... 6 1 is an odd number. Therefore, it is unequal and subtracted from *gza' bar*. In the case of step index 6, *rkang sdom* is 24. The *sgyur byed* is 1. multiply 1 by *ril cha* (in this case 123) and then divide by 126. $\frac{1 \times 123}{126} = \mathbf{0}$ *yang dag rgyu ba'i dus kyi chu tshod* ...... 123 $\frac{123 \times 60}{126} = \mathbf{58}$ *yang dag rgyu ba'i dus kyi chu srang* ...... 72 $\frac{72 \times 6}{126} = \mathbf{3}$ *yang dag rgyu ba'i dus kyi dbugs* ...... 54 $\frac{54 \times 707}{126} = \mathbf{303}$ *yang dag rgyu ba'i dus kyi cha shas* In the case of ***snga rkang* (early step),** the *rkang sdom* is **added** to *yang dag rgyu ba'i chu tshod*. **24** + $\mathbf{0^{q}58'3''303'''}$ = $\mathbf{24^{q}58'3''303'''}$. subtracted from *gza' bar* $0^{z}50^{q}12'5''11'''$ (7/60/60/6/707). (1: odd number and is then unequal and subtracted from *gza' bar*)	*nyi bar:* $20^{k}20^{q}2'1''29'''$ (27/60/60/6/67) $-\ 6^{k}45^{q}$ $13^{k}35^{q}2'1''29'''$ *dor* : deductible. $-\ 13^{k}30^{q}$ $0^{k}5^{q}2'1''29'''$ *sgyur byed* : 6, *rkang sdom* step total: 0 $\frac{5 \times 6}{135} = \mathbf{0}$ ...... 30 *yang dag rgyu ba'i yul gyi chu tshod* $\frac{2 \times 6 + 30 \times 60}{135} = \mathbf{13}$ ...... 57 *yang dag rgyu' ba'i yul gyi chu srang* $\frac{1 \times 6 + 57 \times 6}{135} = \mathbf{2}$ ...... 78 *yang dag rgyu' ba'i yul gyi dbugs* $\frac{29 \times 6 + 78 \times 67}{135} = \mathbf{40}$ ...... 0 *yang dag rgyu' ba'i yul gyi cha shas* $\mathbf{0^{q}13'2''40'''}$ + 0 + $20^{k}20^{q}2'1''29'''$ = $\mathbf{20^{k}20^{q}15'4''2'''}$: ***nyi dag***	$0^{q}13'2''40'''$ + *gza' phyed dag pa* $0^{z}25^{q}14'1''39'''232''''$ = $\mathbf{0^{z}25^{q}27'4''12'''232''''}$: ***gza' dag***

Table 29. ***Sgra gcan* Values**

sgra gcan rtsa $6^{k}2^{q}44'2''2'''$	***sgra gcan gdong*** $20^{k}57^{q}15'3''21'''$, ***sgra gcan mjug*** $7^{k}27^{q}15'3''21'''$
$\frac{(479+32)}{230} = 2$ ...... 51 $51 \times 30 + 15 = 1545$ $1545 \times 0 + 6 = \mathbf{6}$ $\frac{(1545 \times 0+362)}{60} = 6$ ...... **2** $\frac{(1545 \times 14 + 134)}{60} = 362$ ...... **44** $\frac{(1545 \times 0 + 806)}{6} = 134$ ...... **2** $\frac{1545 \times 12}{23} = 806$ **2**	$27 - 6^{k}2^{q}44'2''2''' = \mathbf{20^{k}57^{q}15'3''21'''}$ $13^{k}30^{q} + 20^{k}57^{q}15'3''21''' = \mathbf{7^{k}27^{q}15'3''21'''}$

Calculation #4. *Dga' ldan rtsis gsar* 1785/12/29[520]

Epoch data at 1747/3/0 in the case of Sum pa's *Dga' ldan rtsis gsar*

True month: 0/10 (1/65), *gza' dhru'i 'phro*: $1^{z}55^{q}$13'3"333"' = $1^{z}55^{q}$13'3"31"'394""(67/707), *ril/cha*: 24/22 (28/126), *nyi dhru'i 'phro*: $26^{k}39^{q}$51'0"18"'(67), Rāhu: 32.

Table 30.

1.*zla dag*: 479, *mda' ro lhag ma*: 30 $1785 - 1747 = 38$ $12 - 3 = 9$ $(38 \times 12 + 9) + 14 = 465 + 14$ $= \mathbf{479}$: ***zla dag*** $(38 \times 12 + 9) \times 2 + 10 = 940$ $\frac{940}{65} = 14$ ...... **30:** ***mda' ro lhag ma***	**2. *gza' dhru*: $0^{z}4^{q}$17'4"478"'** $\frac{(479 \times 1 + 1 + 255)}{7} = 105$ ...... **0** $\frac{(479 \times 31 + 55 + 400)}{60} = 255$ ...... **4** $\frac{(479 \times 50 + 13 + 54)}{60} = 400$ ...... **17** $\frac{(479 \times 0 + 3 + 325)}{6} = 54$ ...... **4** $\frac{(479 \times 480 + 333)}{707} = 325$ **478**	**3. *ril cha*: 5/123** $\frac{(479 \times 2 + 24 + 3)}{28} = 35$ ...... **5** $\frac{(479 \times 1 + 22)}{126} = 3$ **123**
4. *nyi dhru*: $19^{k}14^{q}$33'0"54"' $\frac{(479 \times 2 + 26 + 88)}{27} = 39$ ...... **19** $\frac{(479 \times 10 + 39 + 465)}{60} = 88$ ...... **14** $\frac{(479 \times 58 + 51 + 100)}{60} = 465$ ...... **33** $\frac{(479 \times 1 + 0 + 121)}{6} = 100$ ...... **0** $\frac{(479 \times 17 + 18)}{67} = 121$ **54**	**5. *gza' bar*: $1^{z}36^{q}$7'5"251"'** Two methods: 1) search the 30th day value in the table of *grub rtsis kyi gza'i rtag longs.* 2) $0^{z}59^{q}$3'4"16 (707) × 30 = $1^{z}31^{q}$50'0"480"' The results are the same. $1^{z}31^{q}$50'0"480"' + *gza' dhru* $0^{z}4^{q}$17'4"478"' = **$1^{z}36^{q}$7'5"251"'** (7/60/60/6/707).	**6. *nyi bar*: $21^{k}25^{q}$31'2"4"'** Two methods: 1) search the 30th day value in the table of *grub rtsis kyi nyi ma'i rtag longs.* 2) $0^{k}4^{q}$21'5"43(67) × 30 = $2^{k}10^{q}$58'1"17 (67). The results are the same. $2^{k}10^{q}$58'1"17"' (67) + *nyi dhru* $19^{k}14^{q}$33'0"54"' = **$21^{k}25^{q}$31'2"4"'** (27/60/60/6/67).

[520] In the case of the *Dga' ldan rtsis gsar*, 1785/12/26 is *lhag* (Jan 25, 1786 and Jan 26, 1786). 1785/12/29 (Jan 29, 1786) is followed by 1785/12/30 (Jan 30, 1786).

Table 30 (continued)

7. *gza' phyed dag pa*: $2^{z}0^{q}9'1''655'''$ [= $2^{z}0^{q}9'1''62'''51''''$ (*cha shas shed snyoms*)] $\frac{(30+5)}{14} = 2 \ldots\ldots 7$ 2 is an even number. Therefore, it is equal and added to *gza' bar* later. In case that step index is 7, the *rkang sdom* is 25 and the *sgyur byed* is 1. Multiply 1 by *ril cha* (in this case 123) and divide by 126. $\frac{1 \times 123}{126} = \mathbf{0}$ *yang dag rgyu ba'i dus kyi chu tshod* ...... 123 $\frac{123 \times 60}{126} = \mathbf{58}$ *yang dag rgyu ba'i dus kyi chu srang* ...... 72 $\frac{72 \times 6}{126} = \mathbf{3}$ *yang dag rgyu ba'i dus kyi dbugs* ...... 54 $\frac{54 \times 707}{126} = \mathbf{303}$ ...... *yang dag rgyu ba'i dus kyi cha shas* In the case of ***phyi rkang*** (later step), the *rkang sdom* is **subtracted** from *yang dag rgyu' chu tshod*. 25 ($= 24^{q}59'5''707'''$) $- 0^{q}58'3''303''' = 24^{q}1'2''404'''$. 2 is an even number. Therefore, it is equal and added to *gza' bar*. *gza' bar* $1^{z}36^{q}7'5''251'''$ (7/60/60/6/707) + $24^{q}1'2''404''' =$ **$2^{z}0^{q}9'1''655''' =$ *gza' phyed dag pa*** **$2^{z}0^{q}9'1''62'''51''''$ (*cha shas shed snyoms*)**	**8. *nyi dag*: $21^{k}28^{q}39'2''28'''$** *nyi bar:* $21^{k}25^{q}31'2''4'''$ (27/60/60/6/67) $-\ 6^{k}45^{q}$ $14^{k}40^{q}31'2''4'''$ *dor*: deductible. $-\ 13^{k}30^{q}$ $1^{k}10^{q}31'2''4'''$ $1^{k}10^{q} = 70^{q}$ $\frac{70}{135} = \mathbf{0}$ *khyim* ...... $\mathbf{70^{q}}$ The *sgyur byed* is 6. Then, the step total is 6. $\frac{70 \times 6}{135} = \mathbf{3}$ ...... 15 *yang dag rgyu ba'i yul gyi chu tshod* $\frac{31 \times 6 + 15 \times 60}{135} = \mathbf{8}$ ...... 6 *yang dag rgyu' ba'i yul gyi chu srang* $\frac{2 \times 6 + 6 \times 6}{135} = \mathbf{0}$ ...... 48 *yang dag rgyu' ba'i yul gyi dbugs* $\frac{4 \times 6 + 48 \times 67}{135} = \mathbf{24}$ ...... 0 *yang dag rgyu' ba'i yul gyi cha shas* **$3^{q}8'0''24'''$** + 0 + $21^{k}25^{q}31'2''4'''$ **$= 21^{k}28^{q}39'2''28'''$: *nyi dag***	**9. *gza' dag*: $2^{z}3^{q}17'2''19'''51''''$** *gza' phyed dag pa* $2^{z}0^{q}9'1''62'''51'''' + 3^{q}8'0''24''' + 0$ $=$ **$2^{z}3^{q}17'2''19'''51''''$: *gza' dag*.**

Table 31. ***Sgra gcan*** **Values**

sgra gcan rtsa **$6^{k}6^{q}15'3''21'''$** $\frac{(479+32)}{230} = 2 \ldots\ldots 51$ $51 \times 30 + 30 = 1560$ $1560 \times 0 + 6 = \mathbf{6}$ $\frac{(1560 \times 0 + 366)}{60} = 6 \ldots\ldots \mathbf{6}$ $\frac{(1560 \times 14 + 135)}{60} = 366 \ldots\ldots \mathbf{15}$ $\frac{(1560 \times 0 + 813)}{6} = 135 \ldots\ldots \mathbf{3}$ $\frac{1560 \times 12}{23} = 813 \ldots\ldots \mathbf{21}$	***sgra gcan gdong*** **$20^{k}53^{q}44'2''2'''$**, ***sgra gcan mjug*** **$7^{k}23^{q}44'2''2'''$** $27 - 6^{k}6^{q}15'3''21''' = \mathbf{20^{k}53^{q}44'2''2'''}$ $13^{k}30^{q} + 20^{k}53^{q}44'2''2''' = \mathbf{7^{k}23^{q}44'2''2'''}$

Calculation # 5. *Byed rtsis* 1785/12/15

Epoch data at* 806/3/0 in the case of *byed rtsis

True month: 0/0 (1/65), *gza' dhru'i 'phro*: $2^{z}30^{q}$, *ril cha'i 'phro*: 5/112 (28/126), *nyi dhru'i 'phro*: $26^{k}58^{q}0'0''0'''$(13), Rāhu: 122.[521]

Table 32.

1. *zla dag*: 12118, *mda' ro lhag ma*: 49	**2. *gza' dhru*: $6^{z}46^{q}20'$**	**3. *ril cha*: 6/8**
$1785 - 806 = 979$ $12 - 3 = 9$ $(979 \times 12 + 9) + 361 = \mathbf{12118}$: ***zla dag*** $(979 \times 12 + 9) \times 2 + 0 = 23514$ $\frac{23514}{65} = 361$ ...... **49**: ***mda' ro lhag ma***	$\frac{(12118 \times 1 + 2 + 6429)}{7} = 2649$ ...... **6** $\frac{(12118 \times 31 + 30 + 10098)}{60} =$ 6429 ...... **46** $\frac{(12118 \times 50 + 0)}{60} = 10098$ **20**	$\frac{(12118 \times 2 + 5 + 97)}{28} = 869$ ...... **6** $\frac{(12118 \times 1 + 112)}{126} = 97$ **8**

[521] For the epoch value, see Henning (2013c). According to Schuh's (1973a/2012) classification, this case is m = 2. Schuh's tables in Schuh (1973a) includes m = 3 and m = 4. Addition to the table the case of m = 2 in 1785 C.E. occurs as follows:

Tibetan month	m = 2					m = 3					m = 4				
	the first day of each month	*lhag chad*				the first day of each month	*lhag chad*				the first day of each month	*lhag chad*			
1	10.2.1785	-3	19	-27	0	10.2.1785	-3	19	-27	0	9.2.1785	0	0	0	0
2	11.3.1785	0	0	0	0	11.3.1785	0	0	0	0	11.3.1785	-6	11	-29	0
3	9.4.1785	-1	13	-24	0	9.4.1785	-1	13	-24	0	9.4.1785	14	-23	0	0
4	9.5.1785	-27	0	0	0	9.5.1785	-27	0	0	0	9.5.1785	-28	0	0	0
5	7.6.1785	8	-20	0	0	7.6.1785	8	-20	0	0	7.6.1785	7	-21	0	0
6	7.7.1785	-23	0	0	0	7.7.1785	-23	0	0	0	7.7.1785	-25	0	0	0
7	5.8.1785	5	-16	0	0	5.8.1785	5	-16	0	0	5.8.1785	2	-18	0	0
8	4.9.1785	-19	30	0	0	4.9.1785	-19	0	0	0	4.9.1785	-20	29	0	0
9	4.10.1785	-12	0	0	0	4.10.1785	1	-12	0	0	4.10.1785	-13	0	0	0
10	2.11.1785	-16	24	0	0	2.11.1785	-16	24	0	0	2.11.1785	-16	25	0	0
11	2.12.1785	-10	27	0	0	2.12.1785	-10	27	0	0	2.12.1785	-9	0	0	0
12	1.1.1786	-4	0	0	0	1.1.1786	-5	0	0	0	31.12.1785	-14	19	0	0

Table 32 (continued)

4. *nyi dhru*: 19^{k}25^{q}16'5"7"'[522] $\frac{(12118 \times 2 + 26 + 2217)}{27} = 980$ ...... **19** $\frac{(12118 \times 10 + 58 + 11807)}{60} = 2217$ ...... **25** $\frac{(12118 \times 58 + 0 + 5592)}{60} = 11807$ ...... **16** $\frac{(12118 \times 2 + 0 + 9321)}{6} = 5592$ ...... **5** $\frac{(12118 \times 10 + 0)}{13} = 9321$ **7**	**5. *gza' bar*: 0^{z}32^{q}15'0"**[523] 0^{z}45^{q}55'0" + *gza' dhru* 6^{z}46^{q}20'0" = **0^{z}32^{q}15'0"** (7/60/60/6) For the value of the 15th day, read the table of *byed pa'i gza'i rtag longs.*	**6. *nyi bar*: 20^{k}30^{q}46'0"12"'** 1^{k}5^{q}29'1"5"' (13) + *nyi dhru* 19^{k}25^{q}16'5"7"' = **20^{k}30^{q}46'0"12"'** (27/60/60/6/13)
7. gza' phyed dag pa*: 0^{z}7^{q}18'63" (78)** $\frac{(15+6)}{14} = 1$ ...... 7 $\frac{1 \times 8}{126} = \mathbf{0}$ *yang dag rgyu ba'i dus kyi chu tshod* ...... 8 $\frac{8 \times 60}{126} = \mathbf{3}$ *yang dag rgyu ba'i dus kyi chu srang* ...... 102 $\frac{102 \times 6}{126} = \mathbf{4}$ *yang dag rgyu ba'i dus kyi dbugs* ...... 108 $\frac{108 \times 13}{126} = \mathbf{11}$ ...... 18 *yang dag rgyu ba'i dus kyi cha shas* 1 is an odd number. Therefore, it is subtracted later. In case step index is 7, *rkang sdom* is 25 and the *sgyur byed* is 1. Multiply 1 by *ril cha* (8 in this case), and then divide the result by 126. In the case of ***phyi rkang (later step), the *rkang sdom* is subtracted from *yang dag rgyu ba'i chu tshod*. **25** − **0^{q}3'4"11"'** = **24^{q}56'1"2"'**(60/60/6/13). 1 is an odd number. Therefore, it is subtracted. *gza' bar* 0^{z}32^{q}15'0"(7/60/60/6) − 0^{z}24^{q}56'1"2"' = **0^{z}7^{q}18'63" (78)**[524] **: *gza' phyed dag pa***	**8. *nyi dag*: 20^{k}31^{q}28'1"3"'** *nyi bar:* 20^{k}30^{q}46'0"12"' (27/60/60/6/13) − 6^{k}45^{q} 13^{k}45^{q}46'0"12"' − 13^{k}30^{q} *dor*: deductible. 0^{k}15^{q}46'0"12"' *0 khyim*, early step. The *sgyur byed* is 6, the *rkang sdom* is 0. $\frac{15 \times 6}{135} = \mathbf{0}$ ...... 90 *yang dag rgyu ba'i yul gyi chu tshod* $\frac{46 \times 6 + 90 \times 60}{135} = \mathbf{42}$ ...... 6 *yang dag rgyu' ba'i yul gyi chu srang* $\frac{0 \times 6 + 6 \times 6}{135} = \mathbf{0}$ ...... 36 *yang dag rgyu' ba'i yul gyi dbugs* $\frac{12 \times 6 + 36 \times 13}{135} = \mathbf{4}$ ...... 0 *yang dag rgyu' ba'i yul gyi cha shas* 20^{k}30^{q}46'0"12"' + **0^{k}0^{q}42'0"4"'** = **20^{k}31^{q}28'1"3"': *nyi dag***	**9. *gza' dag*: 0^{z}8^{q}0'5"2"'** *gza' phyed dag pa* 0^{z}7^{q}18'4"11"' + 0^{z}0^{q}42'0"4"' = **0^{z}8^{q}0'5"2"'**

[522] 2^{k}10^{q}58'2"10"'(13) = the mean motion of the sun per one lunar month. In the case of *grub rtsis*, 2^{k}10^{q}58'1"17"' = the mean motion of the Sun per one lunar month.

[523] In the case of *byed rtsis*, the *gza'i rtag longs* (*tshes zhag*) is 0^{z}59^{q}3'4". In the case of *grub rtsis*, *gza'i rtag longs* (*tshes zhag*) is 0^{z}59^{q}3'4"16"'

Table 33. *Sgra gcan* Values

Sgra gcan rtsa $5^k55^q41'4''10'''$ $\frac{(12118+122)}{230} = 53 \ldots\ldots 50$ $50 \times 30 + 15 = 1515$ $1515 \times 0 + 5 = \mathbf{5}$ $\frac{1515 \times 0 + 355}{60} = 5 \ldots\ldots \mathbf{55}$ $\frac{1515 \times 14 + 131}{60} = 355 \ldots\ldots \mathbf{41}$ $\frac{1515 \times 0 + 790}{6} = 131 \ldots\ldots \mathbf{4}$ $\frac{1515 \times 12}{23} = 790 \ldots\ldots \mathbf{10}$ $5^k55^q41'4''10'''$	***Sgra gcan gdong*** $\mathbf{21^k4^q18'1''13'''}$, ***Sgra gcan mjug*** $\mathbf{7^k34^q18'1''13'''}$ $27 - 5^k55^q41'4''10''' = 21^k4\ ^q18'1''13'''$: ***Sgra gcan gdong*** $13^k30^q + 21^k4\ ^q18'3''15''' = \mathbf{7^k34^q18'1''13'''}$: ***Sgra gcan mjug***

Calculation # 6. *Byed rtsis* 1785/12/30

Epoch data at 806/3/0 in the case of *byed rtsis*

True month: 0/0 (1/65), *gza' dhru'i 'phro*: 2^z30^q, *ril cha'i 'phro*: 5/112 (28/126), *nyi dhru'i 'phro*: $26^k58^q0'0''0'''(13)$, and Rāhu: 122.

Table 34.

1. *zla dag*: 12118, *mda' ro lhag ma*: 49 $1785 - 806 = 979$ $12 - 3 = 9$ $(979 \times 12 + 9) + 361 = \mathbf{12118}$: ***zla dag*** $(979 \times 12 + 9) \times 2 + 0 = 23514$ $\frac{23514}{65} = 361 \ldots\ldots \mathbf{49}$: ***mda' ro lhag ma***	**2. *gza' dhru*: $6^z46^q20'$** $\frac{(12118 \times 1 + 2 + 6429)}{7} = 2649 \ldots\ldots \mathbf{6}$ $\frac{(12118 \times 31 + 30 + 10098)}{60} = 6429 \ldots\ldots \mathbf{46}$ $\frac{(12118 \times 50 + 0)}{60} = 10098 \ldots\ldots \mathbf{20}$	**3. *ril cha*: 6/8** $\frac{(12118 \times 2 + 5 + 97)}{28} = 869 \ldots\ldots \mathbf{6}$ $\frac{(12118 \times 1 + 112)}{126} = 97 \ldots\ldots \mathbf{8}$

[524] $0^z7^q18'63''\ (78) = 0^z7^q18'4''11'''(13)$. The *cha shas shed snyoms* is as follows:
$63 \div 78 \times 6 = \mathbf{4}.84615384615$
$0.84615384615 \times 13 = \mathbf{11}$

Table 34 (continued)

4. *nyi dhru*: $19^{k}25^{q}16'5''7'''$ $\frac{(12118 \times 2 + 26 + 2217)}{27} = 980$ ...... **19** $\frac{(12118 \times 10 + 58 + 11807)}{60} =$ 2217 ...... **25** $\frac{(12118 \times 58 + 0 + 5592)}{60} = 11807$ ...... **16** $\frac{(12118 \times 2 + 0 + 9321)}{6} = 5592$ ...... **5** $\frac{(12118 \times 10 + 0)}{13} = 9321$ **7**	**5. *gza' bar*: $1^{z}18^{q}10'0''$** For the value of the 30th day, read the table of *byed pa'i gza'i rtag longs* and that of *nyi ma'i rtag longs.* *gza' bar:* $1^{z}31^{q}50'0''$ + *gza' dhru* $6^{z}46^{q}20'0''$ = $1^{z}18^{q}10'0''$ *(7/60/60/6)*	**6. *nyi bar*: $21^{k}36^{q}15'2''4'''$** $2^{k}10^{q}58'2''10'''$ (13) + *nyi dhru* $19^{k}25^{q}16'5''7'''$ = **$21^{k}36^{q}15'2''4'''$** (27/60/60/6/13)
7. *gza' phyed dag pa*: $1^{z}42^{q}2'2''4'''$ $\frac{(6+30)}{14} = 2$ ...... 8 2 is an even number. Therefore, it is added later. In the case the step index is 8, the *rkang sdom* is 24, and the *rkang bzung* is 2. *8 × 2 =* $\frac{16}{126} = \mathbf{0}$ ...... 16 *yang dag rgyu ba'i dus kyi chu tshod* $\frac{16 \times 60}{126} = \mathbf{7}$ ...... 78 *yang dag rgyu ba'i dus kyi chu srang* $\frac{78 \times 6}{126} = \mathbf{3}$ ...... 90 *yang dag rgyu ba'i dus kyi dbugs* $\frac{90 \times 13}{126} = \mathbf{9}$ ...... 36 *yang dag rgyu ba'i dus kyi cha shas* 24 − **$0^{q}7'3''9'''$** = $23^{q}52'2''4'''$ *gza' bar* $1^{z}18^{q}10'0''$ (7/60/60/6) + $0^{z}23^{q}52'2''4'''$ = **$1^{z}42^{q}2'2''4'''$: *gza' phyed dag pa***	**8. *nyi dag*: $21^{k}39^{q}52'0''5'''$** *nyi bar:* $21^{k}36^{q}15'2''4'''$ (27/60/60/6/13) − $6^{k}45^{q}$ $14^{k}51^{q}15'2''4'''$ − $13^{k}30^{q}$ *dor*: deductible. $1^{k}21^{q}15'2''4'''$ $\frac{81}{135} = 0$ *khyim* ...... 81 *chu tshod* *0 khyim*, early step. The *sgyur byed* is 6, the *rkang sdom* is 0. $\frac{81 \times 6}{135} = \mathbf{3}$ ...... 81 *yang dag rgyu ba'i yul gyi chu tshod* $\frac{15 \times 6 + 81 \times 60}{135} = \mathbf{36}$ ...... 90 *yang dag rgyu' ba'i yul gyi chu srang* $\frac{2 \times 6 + 90 \times 6}{135} = \mathbf{4}$ ...... 12 *yang dag rgyu' ba'i yul gyi dbugs* $\frac{4 \times 6 + 12 \times 13}{135} = \mathbf{1}$ ...... 45 *yang dag rgyu' ba'i yul gyi cha shas* $21^{k}36^{q}15'2''4'''$ + **$0^{k}3^{q}36'4''1'''$** = **$21^{k}39^{q}52'0''5'''$: *nyi dag***	**9. *gza' dag*: $1^{z}45^{q}39'0''5'''$** $1^{z}42^{q}2'2''4'''$ + $0^{z}3^{q}36'4''1'''$ = **$1^{z}45^{q}39'0''5'''$**

The values of *gza' dag* and *nyi dag* for the lunar eclipse calculations at 1785/12/15[525] are as follows:

[525] I did not have a chance to seriously investigate the values and methods of the lunar and solar eclipse calculations in the three individual systems. Henning (2007: chapter 3) is the most advanced research for the eclipse calculation methods of the *grub rtsis* and the *byed rtsis*. My topic is to demonstrate background knowledge on *rtsis 'phro* corrections and their influence in the calculated results with regard to eclipses. For modern computations for this eclipse, see von Oppolzer, tr. Gingerich (1962: 371), Liu and Fiala (1992: 152),

Table 35.

	Phug pa grub rtsis (calculation # 1)	*Dga' ldan rtsis gsar* (Calculation # 3)	*byed rtsis* (Calculation # 5)
gza' dag	$0^{z}21^{q}$36'2"29"'505"" ⓐ	$0^{z}25^{q}$27'4"12"'232"" ⓑ	$0^{z}8^{q}$0'5"2"' ⓒ
nyi dag	$19^{k}48^{q}$41'3"57"' ⓓ	$20^{k}20^{q}$15'4"2"' ⓔ	$20^{k}31^{q}$28'1"3"' ⓕ

ⓑ − ⓐ = $0^{z}3^{q}$51'1"49"'434"" (7/60/60/6/67/707/). The result is fixed. Also, see the case at 1785/12/30.

ⓐ − ⓒ is the subtraction between different radices, i.e. (7/60/60/6/67/707) and (7/60/60/6/13). The *cha shas shed snyoms* is needed.

$0^{z}21^{q}$36'2"5"'51""202""'[526] − $0^{z}8^{q}$0'5"2"' = $0^{z}13^{q}$35'3"3"'51""202""' (7/60/60/6/13/67/707/) . The results may vary.

ⓑ − ⓒ = $0^{z}25^{q}$27'4"2"'26""188""' (7/60/60/6/67/707/) − $0^{z}8^{q}$0'5"2"' = $0^{z}17^{q}$26'5"0"'26""188""' (7/60/60/6/13/67/707/)

and Espenak and Meeus, Five Millenium Canon of Lunar Eclipses −1999 to + 3000 [See NASA eclipse website]. Regarding Δ T, for further information on one of the major factors that causes the observed differences in the calculations, see de Meis (2002: 3-4), Sivin (2009: 116-8).

[526] $29 \times 707 + 505 = 21008$

$21008 \times 13 = 273104$

$\frac{273104}{707} = 386.285714286$

$\frac{386.285714286}{67} = \mathbf{5}.76545842218$

$5.76545842218 - 5 = 0.76545842218$

$0.76545842218 \times 67 = \mathbf{51}.2857142861$

$51.2857142861 - 51 = 0.2857142861$

$0.2857142861 \times 707 = \mathbf{202}.000000273$

ⓔ − ⓓ = $0^{k}31^{q}26'0''12'''$ (27/60/60/6/67) The result is fixed. Also, see the case at 1785/12/30.

ⓕ − ⓓ = $20^{k}31^{q}28'1''3'''$(27/60/60/6/13) − $19^{k}48^{q}41'3''11'''4''''$(27/60/60/6/67) = $0^{k}42^{q}46'3''4'''63''''$ (27/60/60/6/13/67).

ⓕ − ⓔ = $20^{k}31^{q}28'1''3'''$ (27/60/60/6/13) − $20^{k}20^{q}15'4''0'''26''''$ (27/60/60/6/67) = $0^{k}11^{q}12'3''2'''41''''$ (27/60/60/6/13/67).

The values of *gza' dag* and *nyi dag* for the solar eclipse calculations for 1785/12/30[527] are as follows:

Table 36.

	Phug pa grub rtsis (calculation # 2)	*Dga' ldan rtsis gsar* (Calculation # 4)	*byed rtsis* (Calculation # 6)
gza' dag	$1^{z}59^{q}26'0''36'''324''''$(a)	$2^{z}3^{q}17'2''19'''51''''$(b)	$1^{z}45^{q}39'0''5'''$(c)
nyi dag	$20^{k}57^{q}5'2''16'''$(d)	$21^{k}28^{q}39'2''28'''$(e)	$21^{k}39^{q}52'0''5'''$(f)

(b) − (a) = $0^{z}3^{q}51'1''49'''434''''$ (7/60/60/6/67/707/) The result is fixed. Also, see the case at 1785/12/15.

(a) − (c) = $1^{z}59^{q}26'0''7'''4''''677'''''$ − $1^{z}45^{q}39'0''5'''$ (7/60/60/6/13) = $0^{z}13^{q}47'0''2'''4''''677'''''$ (7/60/60/6/13/67/707/).

[527] For modern computations for this solar eclipse, see von Oppolzer (1962: 371), Watanabe (1979: 270), Stephenson and Houlden (1986: 414), and Espenak and Meeus, Five Millennium Canon of Solar Eclipses. − 1999 to + 3000 [See NASA eclipse website: http://eclipse.gsfc.nasa.gov/SEsearch/SEsearchmap.php?Ecl=17860130]. Actually, no solar eclipse occurred in Tibet on 1785/12/30.

(b) – (c) = $2^{z}3^{q}$17'2"3"'46""663""' (7/60/60/6/67/707/) – $1^{z}45^{q}$39'0"5"' (7/60/60/6/13) = $0^{z}17^{q}$38'1"11"'46""663""' (7/60/60/6/13/67/707/).

(e) – (d) = $0^{k}31^{q}$26'0"12"' (27/60/60/6/67) The result is fixed. Also, see the case at 1785/12/15.

(f) – (d) = $21^{k}39^{q}$52'0"5"' (27/60/60/6/13) – $20^{k}57^{q}$5'2"3"'7""' (27/60/60/6/67) = $0^{k}42^{q}$46'4"1"'60""' (27/60/60/6/13/67).

(f) – (e) = $21^{k}39^{q}$52'0"5"' (27/60/60/6/13) – $21^{k}28^{q}$39'2"5"'29""' (27/60/60/6/67) = $0^{k}11^{q}$12'3"12"'38"" (27/60/60/6/13/67).

It has been verifed from the above tables and calculations that the different *rtsis 'phro* values between the *Phug pa grub rtsis* and the *Dga' ldan rtsis gsar* and the different *rtag longs* and *rtsis 'phro* values between the *Phug* traditions (*Phug pa grub rtsis* and *Dga' ldan rtsis gsar*) and the *byed rtsis* cause the difference of *nyi dag* (also *tshes 'khyud zla skar* in the case of lunar eclipses), which surely influence the determination of eclipse possibility. In the case of a lunar eclipses, the *tshes 'khyud zla skar* value of the 15^{th} day is compared to the *sgra gcan gdong/ mjug* ; in the case of a solar eclipse, the *nyi dag* value of the 30^{th} day is compared with *sgra gcan gdong/ mjug.*[528] Of course, *nur ster* is considered in the case of the *grub rtsis*.

[528] For example, the possible cases of a solar eclipse in Dharmaśrī's *Gser gyi shing rta* are thus: 1) *nyi dag* of the 30^{th} day – corrected (= *nur ster* was applied) *gdong* < 45 *chu tshod* (50 *chu tshod* is possible), 2) corrected *mjug* – *nyi dag* of the 30^{th} day < 40, 3) corrected *gdong* – *nyi dag* of the 30^{th} day < 5, 4) *nyi dag* of the 30^{th} day – corrected *mjug* < 8. These values used are on an empirical basis (*myong rtsis*). For more information see Henning (2007: 129), and Dharmaśrī (1983: 256-7)

I stress the following two points: the different *rtsis 'phro*-s between the *Phug pa grub rtsis* (*Pad dkar zhal lung*) and the *Dga' ldan rtsis gsar* are the outcome from observations of eclipse occurrences for the purpose of accurate eclipse calculation.[529] In addition, as seen in A kya's calculations, multiple systems are used in Tibet. Under these circumstances, there is no guarantee that a certain calculation method is always right and no systems can be ruled out. This presents a paradox in which different values and methods are affirmed and referred to at the same time.

After a judgement regarding eclipse possibility, calculations of timing, direction, magnititude, etc., follow, which are beyond the scope of this current work.[530] Instead, A kya's observations are presented, based upon his calculations.

A KYA'S CALCULATIONS AND OBSERVATIONS OF THE ECLIPSES

A kya's calculation (possibly including his observation) for the lunar eclipse at 1785/12/15 is as follows:

> *nya yi nyin gyi res gza' nyi ma'i bu'i*[531] */ chu tshod de nyid* (25)[532] *yongs su zad pa yi / sa mo bya yi dus kyi thog ma ru / shar nye'i phyogs nas khams gsum rnam rgyal*[533] *gyi / mjug ma'i me dpung*

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[529] For this, see Sum pa Mkhan po (1979c: 13b).

[530] See Henning (2007: chapter 3).

[531] *res gza' nyi ma'i bu* = Saturday (*gza' spen pa*). *nyi ma'i bu* is Saturn (T. *spen pa*).

rab tu 'bar ba yis / sa mo'i (*sic.* read *sa mos*) *gnyen*[534] *gyi dkyil 'khor cha bdun tsam / bsregs nas slar yang chu tshod ri bo (7) tsam / song tshe lus pa'i phyogs nas rim gyis sos /*[535]

At the beginning of the time of the earth-female-bird (T. *sa mo bya*) at which 25 *chu tshod* completely ended, on Saturday, of the full moon day, the flame of the tail of Rāhu flared up from near to the east, 7 *cha* (= i.e. $\frac{7}{10}$) of the disc of the moon burned, and then again when 7 *chu tshod* passed, [the moon] was restored from the part where it began.

It began at the time of *bya* (possibly 5-7 p.m. in Amdo),[536] lasted during 7 *chu tshod* (24 modern minutes $\times$ 7 $=$ 168 minutes), and was then restored. A kya's prediction for the solar eclipse at 1785/12/30 is as follows:

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[532] This means *chu tshod* and below in the value of the *gza' dag*. If the supralinear note 25 was written by him, it means that A kya used the value of the *Dga' ldan rtsis gsar*. The *chu tshod* value in the *Dga' ldan rtsis gsar* is 25^{q}. See the value: $0^{z}25^{q}27'4''12'''232''''$. Another possibility: *de nyid* may just mean 'that', i.e. *chu tshod* right before it. In either case, this phrase can be interpreted as the following: according to the *skar rtsis* system, the timing of the eclipse is fixed as the time of termination of the *tshes zhag.* Of course, a correction to the timing may be applied.

[533] For a synonym of *sgra gcan* (M. *raqu*), *khams gsum rnam rgyal* (M. *γurban oron-i tein büged ilaγuγči*) is seen in Lcang skya III et al. (1982: 56) and Lcang skya III et al. (2002: 1195).

[534] In context, it should be *sa mos gnyen* (the moon).

[535] A kya (2000: 2b (47 *ben* (本) *xia* (下) 2)).

[536] This kind of time indication is rare. The *sa mo bya* (earth-female-bird) looks to be the time of bird (*bya.* Ch. *you* (酉)), which falls on 17-19 (= *nyi nub* in the table below). For the *dus tshod bcu gnyis* system combined with *nag rtsis* or the Chinese *nyi khams* (干支), see Henning (2007: 358) (2013c). Also see Bsam 'grub rgya mtsho (2011: 25).

1	2	3	4	5	6	7	8	9	10	11	12
nam langs	*nyi shar*	*nyi dros*	*nyi phyed*	*nyi phyed yol*	*nyi myur*	*nyi nub*	*sa sros*	*srod 'khor*	*nam phyed*	*nam phyed yol*	*tho rangs*

*** for the time zone, see Henning (2007: 358). According him, it is based upon the measurement of local (Lhasa) solar time. More research is needed.

nyin mor byed pa [537] *ma gi ra'i khyim du / dga' bder rol bas chu srin khyim zla zhes / grags pa'i dmar phyogs rdzogs pa gsum pa'i nyin / ... / yongs la grags tshod ltar gyi sbrul dus su / lho la nye ba'i phoygs nas ma zlum pa'i / mun pa'i rang bzhin gdong gis nyi ma'i cha / rgya mtsho'am mda' tsam sgrib cing de nas slar / dbyug gu mtsho'am (4) mda' (5) tsam zad pa tshe / lus pa'i phyogs nas g.yon bskor rim gyis sos /*[538]

On the third *rdzogs pa* day (30th day)[539], the second half of the month known as *chu srin khyim zla* (the 12th month)[540] because the sun plays joyfully in the zodiac of the *chu srin* (S.

The above table may be applicable to the time of *bya* that A kya mentions above, but the timing may vary according to different regions, astronomers, and traditions. In conjunction with this concept, *Rab byung bcu bdun rgyal ba shing rta'i lo tho nyi ma'i 'od zer* [= 2014-2015 calendar] (2013: 196-7): *nam langs* ranges from modern time 06:29 to 08:24 in the case of Lhasa (Actually, the current *lo tho* refers to modern technology for the timing of sun rise and sun set). Another relevant issue is the length of the day and night (*nyin tshad* and *mtshan tshad* respectively) according to the month. In the current *lo tho* published by Lha sa sman rtsis khang, *nyin tshad* ranges from $33^{q}30'$ (*bod zla lnga pa*) to $26^{q}30'$ (*bod zla bcu gcig pa*); *mtshan tshad* ranges from $33^{q}30'$ (*bod zla bcu gcig pa*) to $26^{q}30'$ (*bod zla lnga pa*). The values were well established already during Phyag mdzod's time, at the latest; see Phyag mdzod (1987: 59, 209-11).

537 For a synonym of *nyi ma* (M. *adiy-a*), *nyin byed* (*edür bolγaγči*) is given in Lcang skya III et al. (1982: 53) and Lcang skya III et al. (2002: 1185).

538 A kya (2000a: *kha* 4b [= 47 *ben* (本) *xia* (下) 4]).

539 For the term *rdzogs pa*, see above note 110. This description is not unproblematic. There is no 1785/12/30 in the case of the *grub rtsis* and the *Dga' ldan rtsis gsar*. We need more cases to fully research this topic, but it seems that, in A kya's case, he calculates the timing of the mid-eclipse by taking the 12/30 existent.

540 See Bsam 'grub rgya mtsho (2011: 111): "The tenth *khyim*. The sun abides in the *chu srin khyim* on the occasion of the *nyi bar* value $20^{k}15^{q}$ [when being calculated by] the *khyim zhag*." (*khyim bcu ba / khyim zhag nyi bar skar gnas nyi shu dang chu tshod bco lnga shar skabs nyi ma chu srin khyim la gnas /*). And *chu srin khyim zla* (= the 12th month) should not be confused with *chu srin gyi zla ba* (= the 5th month) based upon the *Rdo rje mkha' 'gro'i rgyud* (S. *Vajraḍākatantra*). See Bsam 'grub rgya mtsho (2011: 158), Klong rdo bla ma (1985: 50-1): Tibetan eleventh month: *sa'i dbang phyug* (S. *bhuvaneśvara*), twelfth month: *'phel ba'i zla ba* (S. *rohitā*), first month: *gti mug zla ba* (S. *mohitā*), second month: *bzang po'i zla ba* (S. *bhadra*), third month: *khyu mchog gi zla ba* (S. *vṛṣabha*), fourth month: *rus sbal gyi zla ba* (S. *kūrma*), fifth month: *chu srin gyi zla ba* (S. *makara*), sixth month: *yugs ma'i zla ba* (S. *raṇḍā*), seventh month: *rme ba'i zla ba* (S. *mikira*), eighth month: *'bug pa'i zla ba* (S. *bhidrika*), ninth month: *'tsho ba'i zla ba* (S. *vyākuli*), tenth month: *rmi lam gyi zla ba* (S. *svapnikā*). For the time divisions in the *Vajraḍākatantra*, See Sugiki (2003: 1009-1008), and Sugiki (2005: espeially 262). Given Sugiki (2003: 1009-1008), the Indian month reckoning looks different from the Tibetan one: *rohitā* is given as the first month. We need more research.

> *makara.* Capricorn), ... 4 or 5 parts (T. *cha.* = $\frac{4}{12}$ or $\frac{5}{12}$) of the sun are obscured by the face of Rāhu, which is not round and dark in nature, at the time of snake, as conventionally known, from the direction near to the south, and then again when 4 or 5 *chu tshod* (S. *daṇḍa*) are completed, [the sun] will be sequentially restored, turning to the left from the part where it began.

The eclipse was predicted to occur at snake time (possibly around 9 -11 a.m. in January 30, 1786 in Amdo), to last during 4-5 *chu tshod* (96-120 modern minutes)[541] before it is restored. In fact, it did not occur anywhere in Tibet including Amdo (see above note 527).

THE RELATIONSHIP BETWEEN *RTSIS 'PHRO* CHANGE AND ECLIPSE CALCULATIONS WITH A FOCUS ON SUM PA MKHAN PO'S *DGA' LDAN RTSIS GSAR*

I maintain that, by adjusting *rtsis 'phro*, *Phug pa* astronomers tried to enhance the agreement between *rtsis* and visible phenomena, inclduing eclipses, solstices, etc. In this section, I investigate the arguments against this point by using Sum pa Mkhan po. First, I examine how he positions his new system in conjunction with the previous *grub rtsis* / *byed rtsis* and the Chinese calendar. Then, I mention the relationships involved in his new system, based upon the *rtsis 'phro* changes and eclipse calculations.

Firstly, the colophon of his *Zla bsil rtsi sbyor dge ldan rtsis gsar* is evidence of his clear voice regarding the appraisal of such different systems as *byed rtsis*, *grub rtsis*, and the Chinese calendar. His opinion on *byed rtsis* is as follows:

[541] This is not likely. In fact, the duration of a solar eclipse at observer's position is short.

... bsdus rgyud tshig zin tsam ni phyi rol pa dang thun mong du 'jig rten pa dang mthun pa gtso bor byas pa lo drug cu re nas gza' nyi'i dhru ba'i nges pa cung zad re bzo dgos pas mi rtag par 'grel chen du bshad pas cung zad rags na'ang phyis su bod kyi mkhas dbang (bu ston chos mgon mkhas grub rje karma pa sogs) snga ma phal cher gyis zhib tu btang ba'i nyi skar rtsis shin tu legs pa'i phyir gza' 'dzin sogs thig zhing zla nyi mig skar la'ang nye mod kyang byed rtsis de dag phal cher gyi cha sogs rags pas lo du ma song tshe skyon cung zad re 'ong bas res gza' sogs kyi ri mo ha cang mi zhib la / ... [542]

... although *byed rtsis* is a little rough since *Vimalaprabhā* states that because *Laghukālacakra*, which, merely by the words, considers foremost being compatible with mundane persons in a way of being common to non-buddhists, should change the root quantity (*nges pa* = *rtsa ba* = *dhru ba* = S. *dhruva* / *dhruvaka*) of *gza' dhru* and *nyi dhru* every 60 year, it is impermanent, because the calculations of *nyi skar* (= spatial position of the sun) made in detail by most of previous learned scholars of Tibet (Bu ston, 'Jam dbyangs Chos kyi mgon po, and Mkhas grub, Karma pa (Karma pa III ?), etc) later are very accurate, eclipse, etc are accurate, and [the values of] the sun and moon are close to observation, but because *cha* (= *chas shas*), etc. of most of those *byed rtsis*-s are rough, errors appear a little respectively when many years passed. Because of that, the value of the *gza'* is extremely inaccurate.

He defends *byed rtsis,* because he supposes that its accuracy is verified by eclipse observation. But, the *gza'* value in *byed rtsis* is not accurate because of *cha shas*.[543]

His criticism towards the *grub rtsis* in the *Pad dkar zhal lung* on the basis of empirical and observational results, and research into Chinese calendar are followed.

... rang gi grub mtha' dang mthun par grags pa'i rtsis dngos ni zhib mod kyang da ltar grags che ba'i zhal lung rjes 'brang dang bcas pa'i lugs la grib ma brtags sogs rags la ma dag pa'am dpyad nyes sam gang ltar yang (grib brtag sogs rags sam dpyad nyes sam gang ltar yang) bod dbus ni lho gling dbus mar med par shar ma'i (rnga yab gzhan) dbus nas nub kyi tshigs bdun pa brgyad pa bcu bzhi pa ci rigs yin par bshad pa de dang nyi ldog sogs 'grig ched du stong chen steng nas rtsis 'phro gsum btsal kyang tshes gza' nyi ril rgyud dngos bstan la nye khul dang rang gi 'dod pa dang mthun pa de las ma rnyed pas rgyud dngos bstan las zla gcig gi bar khyad zhugs pa'i dbang gis nyi dag nyi bar cung zad ma dag pas de dag la brten nas blta dgos pa'i gza' 'dzin mi nges shing khyim sleb dbugs sgang nyi ldog sogs phyis la zla bshol snga thal bas de dag nam zla dus bzhis rang rang thad kyi rtags dang grib ma nya skar sogs dang mi 'grigs shing ring ba dang nyi dag la brten pa'i dbugs sogs

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[542] See Sum pa Mkhan po, Yum pa ed. (2015: Pdf, 587-8). A similar remark is found in his other writings such as Sum pa Mkhan po (1979: 180b) (1979c: 5a-5b).

[543] See also note 418.

kyi tshad ji bzhin ma rnyed par nyi bar tsam la brten pa'i rags skyon dang zla nyi gza' lnga'i ri mo yang mig skar las shin tu ring zhing mi 'grigs pa mngon sum tshad mar snang ba sogs kyi skyon 'ga' zhig mthong ste / bod chen gyi sa tshigs dang mthun par byed phyir du thod dkar yul chen las byung ba'i dus tshod blta byed kyi 'phrul gyi 'khor los dus gzer bzhi yang yang brtags nas 'khrul pa'i dri ma mngon sum tshad mas kyang bsal te nyi dhru sogs ni byed pa spyi las zhag 'ga' zhig gi 'phyis pa dang zhal lung grub pa las zhag drug lhag tsam snga bar byas te mig skar dang mthun zhing da lta'i rgya rtsis dang yang nye bar bzos pa'i tshes zhag dang / de dang mthun pa'i nyin khyim lnga bsdus sngon med legs bshad kyang 'god pa dang ... /[544]

... The one which is known as the calculation compatible with our *siddhānta* is actually accurate, but in the traditions which follow the currently renowned *Pad dkar zhal lung*, the investigation of the shadow of the sun etc are rough and inaccurate or faulty in the examination, in any case. In a way that the center of Tibet is not located in the center of the sourthern continent, [*Pad dkar zhal lung*] calculated the three *rtsis 'phro*-s on top of *stong chen*[545] in order to tally solstice, etc. with the statement that the 7th, 8th, 14th, [something like that] whatever joint (border) of the west from the center of the east (*rnga yab gzhan*[546]), but because [it] only found *tshes gza'*, *nyi* (*nyi dhru*), and *ril* (*ril cha),* which are close to the actual exposition of the *Kālacakratantra* and in accordance with its own assertions, [it] became different up to one month from the actual exposition of the *Kālacakratantra*. Due to that, *nyi dag* (true longitude of the sun) and *nyi bar* (mean longitude of the sun) are inaccurate a little and thus, eclipse, which should be investigated by relying upon the values, is not certain, and because it then follows that *khyim sleb*, *dbugs*, *sgang*, *nyi ldog,* etc.[547] are late and intercalary months are early, they do not agree with the

[544] Sum pa Mkhan po, Yum pa ed. (2015: pdf, 588).

[545] Precisely, it means *stong chen 'das lo* in which *rtsis 'phro* is reflected.

[546] There are four continents, each of which has two sub-continents in Indian Buddhist cosmology: *Pūrvavideha* (T. *Shar gyi lus 'phags po*) in the east: *Deha* (T. *Lus*) and *Videha* (T. *Lus 'phags*); *Jambudvīpa* (T. *'Dzam bu gling*) in the south: *Cāmara* (T. *Rnga yab*), *Aparacāmara* (T. *Rnga yab gzhan*); *Aparagodānīya* (T. *Nub kyi ba blang spyod*) in the west: *Sāthā* (T. *G.yo ldan*) and *Uttaramantriṇa* (T. *Lam mchog 'gro*); *Uttarakuru* (T. *Byang gi sgra mi snyan*) in the north : *Kurava* (T. *Sgra mi snyan*) and *Kaurava* (T. *Sgra mi snyan kyi zla*).

[547] To understand how the terms *dbugs thob*, *khyim slebs*, and *sgang* are used, see Henning (2007: 50-4). Also read Bsam 'grub rgya mtsho (2011: 112, 114-5) and Schuh (2012: 1501, 1347). To take *bod zla bdun pa* in 2010 (*lcag stag*) as an example, the *dbugs* / *khyim slebs* / *sgang* calculations are as follows: 40 (*bshol 'phro* of the month) × 6 ÷ 13 = 18 (quotient. T. *nor*) and 6 (remainder. T. *lhag*).

dbugs	*khyim*	*sgang*
18 − 7 = **11**	**18** (quotient)	18 + 8 = **26**
6 − 2 = 3	6 (remainder)	6 + 3 = 9
0 (= 5) - 4 = 1	0	0 + 1 = 1

The calculations of the *dbugs* values are as follows: look up *tshes grangs* value 11 = $3^{z}49^{q}40'2''176'''$ (707). — For this, see Huang and Chen (1987: 21) and Bsam 'grub rgya mtsho (2009: 50). — Then look up *'dod cha* value corresponding signs of season (T. *nam zla*), four seasons (T. *dus bzhi*), the shadow [of the sun] and *nya skar*,[548] etc. and are remote. In addition, [it] made a rough error by merely relying upon *nyi bar*, without exactly obatining *dbugs tshad*, [*sgang tshad*], etc. by *nyi dag*. Also, [the following] some errors are seen: the values of the moon, sun, and the five planets are extremely remote from observation and no match is seen by *mngon sum tshad ma*,[549] etc. [*Dga' ldan rtsis gsar*] eliminated the mistaken distortions, also by *mngon gum*

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3 $= 0^{z}13^{q}37'4''438'''$ — For this, see Huang and Chen (1987: 87) — Then, *lnga cha* value 1 $= 0^{z}0^{q}54'3''76'''$. — For this, see Huang and Chen (1987: 88), Bsam 'grub rgya mtsho (2009: 122-3). — Next, *zla ba de'i gza' dhru + tshes de'i gza'i rtags longs + 'dod cha + lnga cha* $= 3^{z}0^{q}0'0''0'''$ (For this, see *Bod ljongs sman rtsis khang gi lo tho*. 2010-2011 calendar (2009: 120)) $+ 3^{z}49^{q}40'2''176'''$ (7/60/60/6/707) $+ 0^{z}13^{q}37'4''438''' + 0^{z}0^{q}54'3''76''' = 0^{z}4^{q}12'3''690'''$ is the *gza' bar* value of the *dbugs* in the day 11. For the result, see the calendar (2009: 122).
zla ba de'i nyi dhru + tshes de'i nyi ma'i rtags longs + 'dod cha + lnga cha $= 7^{k}39^{q}24'1''5'''$ (For this, see the calendar (2009: 120)) $+ 0^{k}48^{q}1'2''4'''$ (27/60/60/60/6/67) $+ 0^{k}1^{q}0'2''46''' + 0^{k}0^{q}4'0''12 = 8^{k}28^{q}30'0''0'''$ is the *nyi bar* value of the *dbugs* in the day 11. For the result, see the calendar (2009: 122).
The calculations of the *khyim slebs* values are as follows: look up the day 18. $3^{z}0^{q}0'0''0''' + 3^{z}43^{q}6'0''288''' + 0^{z}27^{q}15'3''170''' = 0^{z}10^{q}21'3''458'''$is the *gza' bar* of the *khyim slebs*. For the result, see the calendar (2009: 123).
$7^{k}39^{q}24'1''5''' + 1^{k}18^{q}34'5''37''' + 0^{k}2^{q}0'5''25''' = 9^{k}0^{q}0'0''0'''$ is the *nyi bar* value of the *khyim slebs*. For the result, see the calendar (2009: 123).
The calculations of the *sgang* values are as follows: $3^{z}0^{q}0'0''0''' + 4^{z}35^{q}35'2''416'''$ (day 26) $+ 0^{z}40^{q}53'1''609''' + 0^{z}0^{q}54'3''76''' = 1^{z}17^{q}23'1''394'''$ is the *gza' bar* value of the *sgang*. For the result, see the calendar (2009: 125).
$7^{k}39^{q}24'1''5'''$ (see *Bod ljongs sman rtsis khang gi lo tho*. 2010-2011 calendar (2009: 120)) $+ 1^{k}53^{q}30'2''46'''$ (27/60/60/60/6/67) $+ 0^{k}3^{q}1'2''4''' + 0^{k}0^{q}4'0''12''' = 9^{k}36^{q}0'0''0'''$ is the *nyi bar* value of the *sgang*. For the result, see the calendar (2009: 125).
And the notation of the *sgang* in almanac is as follows: Schuh's (2008: 226-30) finding and speculation are aloof from Tibetan practice. Phyag mdzod (Huang and Chen (1987: 91)) specifies the method: compare the *gza' bar* value of the *sgang* with *gza' gnas* (in *gza' dag*) value of the relevant date. In doing so, the harmony of the former with the latter is considered. For example, *Bod ljongs sman rtsis khang gi lo tho*: 2010-2011 calendar (2009: 155): the *sgang* value in *bod zla bcu pa* is of day 29, but consider *gza' gnas* value: 1. Then, it is written in day 30. *Bod ljongs sman rtsis khang gi lo tho*: 2010-2011 calendar (2009: 165): the *sgang* value in *bod zla bcu gcig pa* is of day 30, but due to the harmony with the *gza' gnas* (the value: 4), the *sgang* is written in day 1 in *bod zla bcu gcig pa phyi ma*. In case that *gza' gnas*-s are the same, just write the *sgang* down in the same cell. For example, in the case of the *bod zla gnyis pa* in *Bod ljongs sman rtsis khang gi lo tho:* 2010-2011 calendar (2009: 201), the *sgang* is witten in the same cell (day 6). In this case, both the values of the *gza' gnas*-s are 4.

548 The *nya skar* is the *skar ma* of the moon at full moon.

549 Indian Buddhist logicians have accepted *pratyakṣa* (*mngon sum*) and *anumāna* (*rjes dpag*) as two valid areas of knowledge since Dignāga (T. Phyogs kyi glang po. active early 6th c.). See Dignāga's *Pramāṇasamuccaya* (T. *Tshad ma kun btus*) chapter I and Dharmakīrti's (*Chos* kyi grags pa. flourished 7th c.) *Pramāṇavārttika* (T. *Tshad ma rnam 'grel*) chapter III. However, in the system of Phya pa Chos kyi seng ge (1109-1169), who laid the foundation of *tshad ma* in Tibet, a distinction between direct perception (*mngon sum*) and valid perception (*mngon sum gyi tshad ma*) was made, deviating from Dharmakīrti who never claimed that some perceptions are not valid. Phya pa's contention is that cognition is affected by external objects, which are assumed to be real, and thus may be invalid. Meanwhile, the stance of Dharmakīrti's *Yogācāra* is that the external object is

> *tshad ma*, after having examined four *dus gzer* (two solstices and two equinoxes) by the miraculous circle of *dus tshod blta byed* (maybe watch?) which came from a major country (major region. T. *yul chen*) of Thod dkar,[550] in order to agree with the geographical border of the great Tibet. *Nyi dhru*, etc. are several days later than the general *byed rtsis*, and are over six days earlier than the *Pad dkar zhal lung*, and thus [it] agrees with observation, and the *tshes zhag,* which was corrected to be close to the current Chinese calendar / *rgya rtsis*[551] and the unprecedented good saying regarding *nyin khyim lnga bsdus*,[552]which agree with *tshes zhag*, are also written down.

It has been speculated that his criticism towards the *grub rtsis* in the *Pad dkar zhal lung* is based upon his real observations of eclipses, solstices, etc., whose accuracy is immediately perceived by direct perception (*mngon sum*). He believes that the *Pad dkar zhal lung* attempts to figure out the difference between the geographical location of India on,

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that which is manifested by consciousness, and thus cognition cannot be invalid. Despite Sa skya Paṇḍita Kun dga' rgyal mtshan's (1182-1251) claim in his *Tshad ma rigs pa'i gter* that the distinction between *mngon sum* and *mngon sum gyi tshad ma* is not justified, Phya pa's epistemology has been dominant among Tibetan intellectuals. Sum pa Mkhan po's use of this term is also based upon Phya pa's understanding and includes cognitive identification.

[550] Martin, https://sites.google.com/site/tibetological/-ol-mo-lung-ring: "*Thod dkar* might be interpreted to mean 'white turban', although some connection with the *thod dkar*, or Tokharian people, might be posited.".

[551] The word *rgya rtsis* is frustrating; we do not know, in most cases, whether it means Chinese astronomy/ astrology in China or Chinese astronomy / astrology researched in Tibet. In addition, this sentence is intriguing in that it shows Sum pa Mkhan po's notion of Chinese astronomy / calendar system. It has been speculated that his understanding of this subject did not increase after the *Dpag bsam ljon bzang* (1748), where we find the same point of view of Chinese astronomy / calendar, in conjunction with *tshes zhag* and *gso sbyong* (See chapter 2). His conviction is based upon his own observations of eclipses.

[552] *Lnga bsdus* (*yan lag lnga*. S. *pañcāṇga*) includes *tshes pa* (S. *tithi.* lunar day), *rgyu skar* (S. *nakṣatra*), *res gza'* (S. *vāra.* weekday), *byed pa* (S. *karaṇa.* half of *tithi*), and *sbyor ba* (S. *yoga*). The components are essentially Indic. See the classical study by Jacobi (1892: 403-60) [= (1970: 948-1005)], Sewell, Dīkṣita and Schram (1996: 3), Schuh (1973a: 81-99), and Schuh (1974: 561).

which the values in the *Kālacakra* are based, and the Tibetan geographical location,[553] but the *rtsis 'phro* and *stong chen 'das lo* values calculated by the system are not accurate. In particular, the *nyi dhru'i 'phro* value is not accurate. Thereby, the *nyi dag* value does not reflect real phenomena, such as seasons, eclipses, and solstices, and the intercalation is also incorrect in Tibet. Being motivated by the inaccuracy, he creates his own system, *Dga' ldan rtsis gsar*, by means of changing *rtsis 'phro* / *stong chen 'das lo* values to achieve correspondence between *rtsis* and astronomical phenomena. This is basically the same approach taken by the *Pad dkar zhal lung*. In other words, the *Pad dkar zhal lung* and Sum pa Mkhan po are similar in that they try to create a system with accurate *rtsis 'phro* / *stong chen 'das lo* values by reflecting both the *Kālacakra* and the geographical location of Tibet. In that sense, his criticism towards *grub rtsis,* which looks to be tied to his research and attitude towards Chinese calendar / *rgya rtsis*, and especially his emphasis on the accurate *nyi dag* for accurate intercalation in Chinese calendar / *rgya rtsis*, can be understood to be based upon the concepts and solutions sought within the *Kālacakra. He* believes his system

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[553] Tibetans have attempted to correct the position of the sun through the determination of accurate equinoxial / solsticial points with a consideration of the different seasonal points between India and Tibet. See Henning (2007: 322 ff). Regarding this issue, Schuh presents an essential problem in the *skar rtsis* based upon the *Kālacakra*: because there is no division between the horizontal coordinate system and equatorial coordinate system in it, it is inevitably reconciled with the incacophony between real observations and the *Kālacakra.* See Schuh (1973a: 54-5), and Schuh (1973a: 57-8): "Die den Himmelsäquator definierende *golarekhā* ist in diesem System zunächst nichts anderes als der, durch die Mitte zwischen den Wendepunkten gegebene, Breitenkreis' des Himmelsgewölbes innerhalb des Horizontsystems." Its corollary that the position of γ is not fixed. See Schuh (1973a: 63): "... dass das Eintreffen der Sonnenwenden für die verschiedenen geographischen Orte dieser Welt in Ost-West-Richtung variiert. Mit anderen Worten: Bei Orten, deren geographische Längen hinreichend verschieden sind, finden die Sonnenwenden an verschiedenen Tagen statt." Schuh (1973a: 113-5) argues that because of this fundamental defect, the fact that the solstice / equinox in Tibet is different from the *Kālacakra* has been recognized by gnomon and ensuingly, some measures have been taken by the 5th Dalai lama, Padma dkar po, Nor bzang rgya mtsho, etc.. For the last one, see Phyag mdzod (1987: 94) as reproduced by Huang and Chen.

is successful in creating an accurate *nyi dag* by calculating accurate *nyi dhru'i 'phro* values. Taken together, his new system, which was written in 1754, was combined with real observations and *byed rtsis*. In addition, the impact of Chinese astronomy on determining accurate *nyi dhru'i 'phro* and *nyi dag* values in his system is connected to his criticism towards *Phug pa grub rtsis*. However, his method to improve them is still conventional.

In the 1780s, specifically his later period, it is still possible ask similar questions regarding the role of Chinese calendars/ *rgya rtsis*, the process of the *rtsis 'phro* change, and effect of the *rtsis 'phro* change, etc in his system as interpreted through his letters, included in Sum pa Mkhan po (1979c). Firstly, We will assess Sum pa Mkhan po's concern about the Chinese calendar/ *rgya rtsis* and its role in the formation of his system. I think this issue is important because it may be a part of his criticism, as seen above. Sum pa Mkhan po's correspondence with Ngag dbang nyi ma, a Sku 'bum lama, in 1785/1786 reads as follows:

> *... rtsis gsar du sngon kha ba can du ma dar ba'i zhag gsum ga'i lnga sgra gza' lnga / da lta'i rgya rtsis dang nye ba'i nyi ldog khyim sleb dbug thob sgang sleb rī ṣi sogs dang / da dus kyi rgya nag rang gi 'byung rtsis dang mthun pa'i sa bdag 'pho 'tshams sogs khyad thon yod do / ...*[554]
>
> ... In *Dga' ldan rtsis gsar*, there are excellent features / uniqueness, such as *lnga bsdus*, *sgra gcan*, *gza' lnga* of three days (T. *zhag gsum*. *tshes zhag*, *nyin zhag*, *khyim zhag*), which did not spread previously in Tibet, and solstices, *khyim sleb, dbug thob, sgang sleb, rī ṣi*, etc which are approximate to the current Chinese astronomy / *rgya rtsis* and the transition of *sa bdag*,[555] etc., which accord with *'byung rtsis* of the present Qing China, etc.

[554] Sum pa Mkhan po (1979c: 91b).

[555] For pioneering research into *sa bdag*, see Schuh (2013). The *sa bdag 'pho 'tshams* is tied to winter solstice.

He is mainly concerned with the intercalation of Chinese astronomy and *rgya rtsis*.[556] This occurs commonly in the colophon of the *Zla bsil rtsi sbyor dge ldan rtsis gsar*, but that is not all. He expresses his opinion on the longitude of the *du ba mjung ring*[557] in a reply to the Paṇ chen lama.

> *... 'di la bu ston rin po ches 'gros bzhi rigs pas bsgrubs kyang mkhas pa grags seng gis rgyud kyi ngos zin dang bstun nas 'gros gnyis kho na bshad pa de rgya nag gi rtsis dang nya (sic. nye) ba 'dra'am snyam / rgya rtsis shig na du ba'i zhag gi longs spyod 'di* (linear note: unclear. */6 / 41 ?) yod pa rim bsags kyis lo dag nas de'i longs spyod rdzogs te nyi ma'i snga phyir thon pa'i rtsis 'char zer ba snang / longs spyod bod rtsis la mthun par byed na* (linear note: the numbers unclear*. . / . / . / 30) 'di'am snyam /*[558]
>
> Regarding this, I think that Bu ston proved four movements (*'gros bzhi*)[559], but Mkhas pa Grags seng's (Zhwa dmar I Grags pa seng ge (1283-1349)) explanation of only two movements (*'gros gnyis*) is in agreement with the recognition that the *Kālacakratantra* is close to Chinese astronomy / *rgya rtsis*. There is a statement that, in Chinese astronomy / *rgya rtsis*, the daily longitude of *du ba* with this quantity (illegible) is fulfilled from the true year (T. *lo dag*) by gradual accumulation, and the calculation appears (?) which comes out

[556] By this evidence, I think that his interests in Chinese astronomy / astrology throughout his life do not show any relationship to the *Mā yang rgya rtsis*. The letter was written around 1785/1786, three years before his death in 1788. — For information on his interests in Chinese astronomy / astrology in his earlier age, see above note 551. — This may mean that the *Mā yang rgya rtsis* did not exist until the 1780s in Amdo. If it had existed, Sum pa Mkhan po, with acuity, would have mentioned it. It is strange that he has never mentioned this text anywhere in his writings.

[557] Bsam 'grub rgya mtsho (2011: 105): "*Ketu* (*du ba mjug ring*) is known as eastern *du ba mjug ring* among the ten planets. The *skyes khyim* is *chu smad* (S. *uttarāṣāḍhā*), the *rtag longs* is the same with the sun, but is visible because of the difference of the beginning steps (T. *rkang pa*) of the four movements (T. *'gros bzhi*) ... ." (*du ba mjug ring*: *ke tu zhes pa gza' bcu'i nang tshan shar gyi du ba mjug ring du grags / skyes khyim chu smad / rtag pa'i longs spyod nyi ma dang mtshungs kyang / 'gros bzhi rtsom pa'i rkang pa'i khyad kyis 'char ba ste / ... .*).

[558] Sum pa Mkha po (1979c: 10a).

[559] For *'gros bzhi / 'gros gnyis*, see above note 557.

before and after the sun [appears].[560] I think that if the longitude is calculated in accordance with Tibetan calculation, the quantity is like this (illegible).

The above passage shows how he understands Chinese astronomy with respect to the *Kālacakra/ skar rtsis*. Unfortunately, because we cannot read the values properly, it is difficult to assess how he equated the Chinese values with the Tibetan ones, but it is known that the concept and ways of the *skar rtsis* function in his understanding of *rgya rtsis*. After this correspondence, the Paṇ chen lama asked again about the *du ba mjug ring* in the subsequent letter and Sum pa Mkhan po answered this way,

> *yang ma hā tsi na'i ljongs kyi bde ldan tong kun*[561] *rgyal po'i rtsis gzhung nang ltar gyi mjug ring gi rtsis bya tshul bod rtsis dang bstun nas sa ri 'bri tshul ni / lo gang gi nyin zhag spyi zhag gnas lnga bkod de / nyin zhag gcig gi rtag longs 'dis 0/0/30/9/ sbel la / rab 'dod me yos kyi rtsis 'phro 'di 8/7/53/6/ byin nas / 'khor lo 'dis 27/60/60/6/24* (?)[562]*bsgril*[563] *na 'char te / lo dgu nas skar ma'i 'khor lo rdzogs par bshad lags / 'on kyang rgyud du 'di 'char ba'i cha shas mtha' yas yod par gsungs pa dang / rgya nag gi skar ma brtags pa'i myong byang na'ang / nam mkha'i skar ma rags pa phal cher la ming btags te / de'i la la'i steng na du 'od rtse lnga dang 'ga' zhig la rtse gsum dang kha cig la zlum po bal 'dra dang phal cher la rtse gcig 'char pa yod par bshad 'dug / des na rgyud dang 'grel bar zla ba don lnga nas du ba 'char gsungs pa byed pa rags rtsis spyi bshad tsam las gzhan dbyibs dang dus sogs mtha' yas pas / zla 'dzin nyi 'dzin ltar du ri mo'i lam nas ji bzhin mtha' gcig tu nges bzung rtogs dka' snyam pa'i dogs pa snang lags /*[564]

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[560] A different translation may be possible: "There is a statement in a Chinese astronomy / *rgya rtsis* that … ." It is assumed in this case that Sum pa Mkhan po personally read the Chinese astronomy / *rgya rtsis.* I am not sure where he cites by *zer ba*.

[561] For this term, see van Schaik and Galambos (2011: 170-3) and van der Kuijp (2010: 125).

[562] Unfortunately, again the values are not properly readable. We need more research into this topic, but I am not sure of the last quantity and do not know why the radix suddenly changed into that of five units. The radices of the previous *rtag longs* and *rtsis 'phro* are composed of four units.

[563] *bsgril* means excess/ surplus. See Bsam 'grub rgya mtsho (2011: 39).

[564] Sum pa Mkhan po (1979c: 12b-13a).

> Also, the arithmetic method [obtained] after having compared the calculation method of *mjug ring,* included in the astronomical text[565] of Elhe taifin Kangxi Emperor of Qing China with the Tibetan calculation method is: it is explained that [the values] will appear if [ ] write *nyin zhag* and *spyi zhag* of any year in five rows, multiply (T. *sbel*) the longitude of a *nyin zhag* by 0/0/30/9/, add 8/7/53/6/, which is the *rtsis 'phro* of the fire-hare year (1747 C.E.) of the 13th *rab byung* [to it], divide by the period 27/60/60/6/24 (?) ... (I do not understand this), and the period is completed in 9 years. However, the *Kālacakratantra* states that the *cha shas* in which this appears is unlimited, and it is also explained in the experience note (T. *myong byang*) which examined Chinese constellation that [ ] gave names to most of the constellation of the heaven roughly, and on top of some of them, there appear *du ba* with light and five peaks, *du ba* with three peaks in a few cases, [*du ba* whose shape is] something like round wool in some cases, *du ba* with one peak in most cases. Therefore, because the statement in the *Laghukālacakra* and the commentary (= *Vimalaprabhā*) that the *du ba* appears within 75 months [is] nothing more than a general explanation [based upon] the rough calculation in the *byed rtsis* ststem, [and in reality] different shapes and timing, etc. are limitless,[566] there arises a doubt in which I think it is difficult to consistently recognize by values, like lunar and solar eclipse.

It is known from the above passage that research existed into Chinese astronomy, as written in the *myong byang,* in which period, shape, color, etc. of the *du ba mjug ring* were recorded. In this passage, Sum pa Mkhan po's approach is to piece the Chinese calendar and *Kālacakra* / *skar rtsis* together and then to arrive at a conclusion. The Tibetan arithmetical considerations of *rtsis 'phro* and *rtag longs*, which were deemed to be the main determinants of different astronomical systems in Tibetan conception, are used to tally *rgya rtsis* calculations with Tibetan ones. The *rtsis 'phro* values combined with the observations are understood to be those that negate the difference between *skar rtsis* and Chinese astronomy, and finally to match *skar rtsis* calculations to real phenomena. This

[565] *Bde ldan* is Elhe taifin Kangxi. This may be the *Rgya rtsis chen mo*. Unfortunately, it seems impossible to pinpoint the exact text.

[566] This means that Sum pa Mkhan po does not completely agree with the statement in the *Laghukālacakra.* It may be his passive way of making an criticism within the frame of the *Kālacakra.*

means that his approach is very conventional, similar to other Tibetan astronomers. They do not get out of the realm of *Kālacakra*. It is difficult to know how much he understood Chinese astronomy, but it does not make him criticize the *skar rtsis* system, which is based upon the *Kālacakra*. The understanding of the times is reconciled with the deep-rooted *skar rtsis* system, as far as it accords with observations / *mngon sum* and contributes "to save the phenomena". From a different perspective, as the world Tibetans witnessed expanded in the 18th century, the *skar rtsis* emerged with a much more complicated context, i.e. how to make sense of Chinese astronomy / *rgya rtsis* within the frame of the *Kālacakra* / *skar rtsis*.[567]

Next, how does Sum pa Mkhan po creates his own system with different *rtsis 'phro* from the *Pad dkar zhal lung*? It is an essential question with regard to the Tibetan astronomical systems, whose differences are determined by *rtsis 'phro* changes. Sum pa Mkhan po's correspondence with the Paṇ chen lama reads as follows.

> *... yang du ba can zhig nam mthong ba nas rtsis 'phro 'dzin na / rab 'dod* (supralinear note: *13*) *sa yos gsum par tho rangs mthong ba la dper mtshon na / lo de'i gsum pa'i tshes zhag gi zla dag 'di ... nyin zhag yin / de mjug ring gi 'khor los* (supralinear note: *65*) *phud pa'i nor 'di (70/21) byung la / de sa yos kyi tho rangs shar ba dang ma 'grigs pas / nor 'dis* (supralinear note: *27) 'khor lor* (supralinear note*: 75) phri* (*sic.*) *lhag la lnga* (supralinear note: *5*) *byung ba 'di rtsis 'phro byas te / sngar* (supralinear note: *70*) *gi nor la byin nas 'khor los* (supralinear note: *75*) *phud pa'i nor la*

[567] In conjunction with this, the reason why *rtsis 'phro* corrections with the creation of new *stong chen 'das los* became prevalent in the 18th century may be related to Tibetan exposure to Chinese astronomy. Sum pa Mkhan po functioned in Inner Asia and Go shrī must have functioned or was influential in Beijing or in Inner Asia, given the xylographs whose numbering in margin is written in Chinese. In addition, as seen from the above quotation from Sum pa Mkhan po, it can be verified that he believed the Chinese almanac / calendar was a reliable source. Under such situations, where the presumably accurate system can be compared with the traditional *skar rtsis* system that already exists and eclipse calculations in the *skar rtsis* method are occasionally proven wrong by direct preception (*mngon sum*), Tibetan astronomers with acuity and a sense of comparison, like Sum pa Mkhan po, may have been quick on the draw.

thig mnyam pa shar bas sa yos kyi tho rangs shar ba dang 'grigs shing / du ba mthong nas zla phyed 'das zer dgos so / rtsis 'phro de rtsis gsar 'di ltar na nam du'ang nges chog / sngon gyi mkhas pa rnams kyis kyang rtsis 'phro so sor de ltar bzhag pa yin nam snyam lags /[568]

... Also, if *rtsis 'phro* is grasped by the observation of a *du ba* every time, to take that which was seen in the third month of the earth-hare year (1759 C.E.) in the thirteenth *rab byung* as an example, this *zla dag* according to *tshes zhag* (better to say *tshes zla*) of the third month of the year ... is *nyin zhag*.[569] The accumulated quotient 70/21 (I do not know whether this is right or not. What is 21?) appeared by the division (T. *phud pa*) of the period (supralinear note: 65) of the *mjug ring*, and because it did not accord with the daybreak [on which day ?] of the earth-hare year, [ ] took 5 (supralinear note: 5), the remainder by the subtraction of the quotient (supralinear note: 27 ?) from the period (supralinear note: 75 ?), as *rtsis 'phro*, and added [the *rtsis 'phro*] to the previous quotient (supralinear note: 70), and then, accuracy appears in the case of the quotient divided by the period (supralinear note: 75). Therefore, it accords with the daybreak of the earth-hare year, and it needs to be said that half month elapsed, after the *du ba* was observed. The *rtsis 'phro* is always fine to be certain according to this new calculation (T. *rtsis gsar*). I suppose that previous learned scholars also placed each *rtsis 'phro* like that.

The following things are explainted in this passage: *tshes zhag* is transformed to *nyin zhag* and the *rtsis 'phro* correction for the purpose of the correspondence between *rtsis* and observed phenomena (= the occurrence of *mjug ring*). We need more research into this subject to be able to properly assess it. However, despite this lack of clarity, the reason I present it is because it clearly states that observations determine the *rtsis 'phro* changes. The *rtsis 'phro* was changed by the observation to "save the phenomena". The *rtsis 'phro* correction is empirical with regards to nature. This may also mean that the continuous observations of eclipses in Tibet played a certain role in the change of *rtsis 'phro*.[570] The

[568] Sum pa Mkhan po (1979c: 13b).

[569] Sum pa Mkhan po explains a method for calculating *nyin zhag* from *tshes zhag*. Since the *par ma* is not clear, I could not read it properly.

[570] Henning (2007: 305-6): "Eclipses are good data points for anybody trying to set up astronomical and calendrical calculations. ... used to adjust the longitude of the Sun and/or Rāhu."

disagreement between *rtsis* and the occurrence of eclipses is manifest through observations. Of course, even if it can be safely assumed that the *rtsis 'phro*-s are composed of and produced by empirical components, there are still more questions: Does the change go beyond the *Kālackara*? Can it be regarded as those corrected by canonical knowledge? Has the possibility that the correction of *rtsis 'phro* has been caused by factors of a non-*Kālacakra* orgin, such as Chinese calendar, been ruled out?[571] At present and according to my knowledge, I cannot answer these important question. We need to accumulate more textual proofs.

Next, let us consider the effects of *rtsis 'phro* corrections in the *Dga' ldan rtsis gsar,* in terms of eclipse predictions. The second letter to Ngag dbang nyi ma in 1785/1786 reads as follows:

> *... zhal lung bai dkar dang kho bo'i ma ltar gyi gza' 'dzin skabs su phri bsnon mang po dang / khyim che ge dang gza' skar ge ge dang 'phrad dus dang / nya'am stong chad dus dang / sbyangs lhag chu tshod la bzhi man dang / nyi bul bsres sogs kyis thig bzhi ma shar na mi 'dzin zhes sogs man ngag lta bu mang du bshad pa ni de dag ltar na de lta bu dgos kyang / kho bo'i zla nyi 'dzin cha 'dzin dus sogs la mi nor ba'i man ngag ni bu gzhung rtsis gsar yin pas / de ltar na sngar mo (sic.* read *snga ma) la de dag gang yang mi dgos par bu'i x* (unclear) *ltar byas na nor pa med dam snyam ste / de ni bu gzhung brtsams pa'i shing khyi nas da lo'i shing sbrul bar gi gza' 'dzin kun (nya stong gi gza' 'dzin ri mo phal cher mthun tsam 'dod) yar log gis bris na shes shing / de ltar nyi ldog sogs la'ang 'dra bas nges la dri ba rab mang ci dgos /*[572]
>
> ... On the occasion of an eclipse in accordance with the *Pad dkar zhal lung*, *Vaiḍūrya dkar po*, and my mother-text (= *Skar nag rtsis kyi snying nor nyung 'dus kun gsal me long*), there are many additions and subtractions, and that which *abundantly state* such *upadeśa* [in the three texts] that if four accuracies, the time when *khyim* such and such and *gza' skar* such and such meet, *chad* in full moon or new moon day, four and below in the remaider of *chu*

[571] For a similar account, Schuh mentions the possibility of the influence of Chinese astronomy on 'Phags pa's astronomical system. See Schuh (1973a: 101-2): the value correction in the latter part of 'Phags pa's *Dhru va gnyis pa'i rtsis* (epoch: 1252), written in 1259, was probably influenced by Chinese astronomy.

[572] Sum pa Mkhan po (1979c: 91b-92a).

tshod after subtraction (T. *sbyangs lhag chu tshod*), and adding *nyi bul*,[573] do not appear, no eclipse occurs, etc. should be like that according to them. However, I think that since the unmistaken *upadeśa* for magnititude, timing, etc. of lunar and solar eclipse is my son-text, *Dga' ldan rtsis gsar* (= *Zla bsil rtsi sbyor dge ldan rtsis gsar*), therefore, there are no mistakes if calculated by my son-text, without needing whichever among the previous three texts: it is known if all the eclipses from the wood-dog year (1754 C.E.) to this year wood-snake year (1785/1786 C.E.) are calculated backwards (it is claimed that the values of the eclipses at the full-moon and new moon day mostly accord), and solstice, etc. are also certain in the similar manner. Then, why [do you] need so many questions?

The *Pad dkar zhal lung* and Sum pa Mkhan po's *ma* text are the same calendar in terms of the same *rtsis 'phro*. But, his *bu* text, which is called *Dga' ldan rtsis gsar*, has different *rtsis 'phro*-s. In the above passage, the difference between *ma* and *bu* in conjunction with eclipse calculation is explained.[574] He was clearly very proud of his new system. The concept of *yar log gi rtsis* is mentioned in arguing for the accuracy of eclipse predictions in his system. The following account also shows that Sum pa Mkhan po is very proud of his new system because of ist accuracy in the prediction for the solar eclipse of 1761.

lo de'i sa ga zla ba'i stod la nyi 'dzin yod pa'i ri mo zhal lung bai dkar lugs dang byed rtsis la yang ma shar yang dga' ldan rtsis gsar la nam langs nas chu tshod drug gi mtshams su nyi ma'i cha gcig lhag tsam 'dzin pa'i ri mo shar ltar 'grig pa mtsho sngon gyi sa cha nas mthong / de'i tshe a la sha nas phyed 'dzin dang mkhar sngon nas ril sgrib byung nas / ...[575]

In the first half of the month of the *sa ga* of the year, the values of the occurrence of the solar eclipse did not occur in the case of the *Pad dkar zhal lung*, *Vaiḍūrya dkar po*, and *byed rtsis*, but in the case of the *Dga' ldan rtsis gsar*, the correspondence [between *rtsis* and the

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[573] For *nyi bul*, see Bsam 'grub rgya mtsho (2011: 92): It indicates the summation of *nyi dag* and *sgra gcan rtsa*.

[574] About the *rtsis 'phro* change in the *Dga' ldan rtsis gsar* and its effect on eclipse calculations, Schuh (1973a: 107) states: "Wahrscheinlich haben Probleme, die sich bei der Berechnung der Mondfinsternisse ergaben, bei der Änderung der Anfangswerte eine wichtige Rolle gespielt."

[575] Sum pa Mkhan po (1979d: 129a) [= (2001: 336)].

> eclipse] was seen in Amdo like the occurrence of the value of more than $\frac{1}{12}$[576] of the sun being eclipsed at the time of approximately 6 *chu tshod* passed from the dawn (T. *nam langs*)[577]. At that time, there was a half eclipse in Alaša (M. Alaša / Ch. Helanshan 賀蘭山/ T. A la sha) and a total eclipse in the Blue City (M. Kökeqota), ...

As seen above, Sum pa Mkhan po is convinced that the new calculations led to accuracy in the eclipse calculations. It may be assumed that his *rtsis 'phro* change is clearly tied to eclipse calculations and to his continous observations on eclipse phenomena for that purpose. At this point, I raise this hypothesis: his argument may be right in his period. From a modern perspective, he just changed *rtsis 'phro* without any theoretical basis. Thus, the effects would be temporary.[578] Then, did he understand whether or not the effects of *rtsis 'phro* corrections are temporary? Straightforwardly, he simply "saved the phenomena" without proving that his system is correct.[579] Čaqar Dge bshes Blo bzang

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[576] The *'dzin cha* index in the *Dga' ldan rtsis gsar* tradition is also 12 like other traditions. —I have not found any other instances in which it is not 12.— For example, see Dbyangs can grub pa'i rdo rje ((n.d.): 7b) (2007: Vol 3, 430).

[577] '*mtshams*' means 'border.' It means the time which is about to become '6 *chu tshod* from the dawn'. I rendered it as 'approximately.'

[578] The Tibetan approach by *rtsis 'phro* change, which has been made possible from observations of eclipses, equinoxes, etc., is basically applicable during a limited time span, even if it is done properly. The *Dga' ldan rtsis gsar* may have worked in the 18th century due to the corrected *rtsis 'phro,* which possibly reflects real eclipse observations that happend in the 18th century. In the same manner, *Byed mthun* (20th c.) may function well in the 20th century. Modern mathematical research would further illuminate this point.

[579] According to Quine (1951) and Quine (1975), who uses Duhem in a holistic approach to theory evaluation in science, it is understood that Sum pa Mkhan po "saved the phenomena by *rtsis 'phro* change," but did not prove that his system is correct. Rather, Sum pa Mkhan po's new system justifies the *Kālacakra* system. He changed the *rtsis 'phro* and thereby contributed to maintaining the stability and reliability of the *Kālacakra* astronomy.

tshul khrims (1740-1810) maintains that the *Dga' ldan rtsis gsar* / Chinese calculations of eclipses are precise.[580]

> *... de yang byed rtsis la bod snga rabs pa'i lugs legs kyang dbugs sgang nyi ldog khyim sleb sogs snga zhing / des gza'i chu tshod kyis gza' 'dzin gyi dus mi 'grig pa sogs 'byung ba dang / grub rtsis la pad dkar zhal lung gi lugs legs kyang nyi dhru la ma dag pa yod pas / zla ba'i cha 'phel 'grib[581] kyi tshes mtshams sogs ma dag par 'gyur bar bshad / lugs re gnyis las khyad par du 'phags pa dge ldan rtsis gsar ni rgya rtsis dang nye zhing / mtshan mo mngon sum du mthong ba'i mig skar la'ang mthun pa dang / gza' 'dzin sogs kyi dus tshod kyang ma nor bar nges pa yin par gsungs so /*[582]
>
> ... Furthermore, it is explained that, in the case of the *byed rtsis,* the earlier Tibetan tradition was good, but *dbugs sgang*, solstices, *khyim sleb*, etc are early and that which the eclipse timing is not right by the amount of the *chu tshod* of the *gza'* value occurs and that in the case of *grub rtsis*, the tradition of the *Pad dkar zhal lung* is good but because there is inaccuracy in the *nyi dhru*, the bordering day between waxing and waning moon, etc are not accurate. It is stated that the *Dga' ldan rtsis gsar,* which is particularly superior to some traditions, is close to Chinese astronomy / *rgya rtsis*[583], and accords with the observations seen by *mngon sum* at night and the timing of eclipse is also certain without mistakes.

He repeats the seemingly wide-spread idea at that time that *byed rtsis* has a problem in the calculation of temporal *gza'* and *grub rtsis* has a problem in the calculation of spatial *nyi dhru*. The reason why he reiterates Sum pa Mkhan po's opinion and follows the *Dga' ldan rtsis gsar* may have been caused by ethnic considerations. Actually, the tradition of *Dga' ldan rtsis gsar* was mostly developed in the Amdo / Mongolian areas, about which

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[580] This quotation was first used by Schuh (1974: 564-5).

[581] The *zla ba'i cha 'phel kyi tshes* ranges from *tshes zhag* 1 to 15; the *zla ba'i cha 'grib kyi tshes* ranges from *tshes zhag* 16 to 30.

[582] Čaqar Dge bshes (2002: 1b).

[583] It is not clear what Čaqar Dge bshes means by "Chinese astronomy / *rgya rtsis*" and no ground is given here by him.

more research is needed.[584] As Čaqar Dge bshes asserts, *Dga' ldan rtsis gsar* may have worked in Inner Mongolia, but modern mathematical and astronomical research with a focus on accuracy could work to prove / disprove it. However, contrary to Čaqar Dge bshes, Mi pham (2012a) shows that in the later period, many trials to correctly calculate eclipses were made incessantly, even after the *Dga' ldan rtsis gsar*.[585] All in all, *rtsis 'phro* changes were not a fundamental solution.

In the above, we briefly examined Sum pa Mkhan po's earlier and later

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[584] It appears that the development of the *Dga' ldan rtsis gsar* has a strong connection to Mongolian lamas. Sum pa Mkhan po himself says he is a Mongolian. See Sum pa Mkhan po (2001: 23-5). Mi pham (2012a: 262) conveys some information on Mongolian adherents of the *Dga' ldan rtsis gsar*: "*Lnga bsdus blo gsal 'dod 'jo* which revised the *rtsis 'phro* of the 15th *rab byung* according to the tradition of the *Dga' ldan rtsis gsar*: ... the one which changed the *dhru ba* of the text with the *rtsis 'phro* written by Sum pa Mkhan po (= *Zla bsil rtsi sbyor dge ldan rtsis gsar*), the same *rtsis 'phro* with the *Rab gsal me long* [I introduced] previously, ... the one that Lcang skya ho thog thu's (M. *J̌anggiy-a qutuγtu*) attendant Dza sag (M. *ǰasaγ* / T. *ja sag*) Mkhan sprul Blo bzang bstan 'dzin nyi ma wrote after having been encouraged by him (= Lcang skya) at the monastery of Chu bzang has many calculation tables." (*... dge ldan rtsis gsar lugs kyi rab byung bco lnga pa'i rtsis 'phro gsar bsgrigs lnga bsdus blo gsal 'dod 'jo zhes pa / ... ye shes dpal 'byor gyis mdzad pa'i rtsis 'phro can de'i nges pa spos pa / sngar gyi rab gsal me long dang rtsis 'phro gcig / ... / chu bzang dgon du cang* (*sic.*) *skyas bskul nas / de'i zhabs 'degs dza sag mkhan sprul blo bzang bstan 'dzin nyi mas bris pa / de'i re'u mig skor mang /*). For Blo bzang bstan 'dzin nyi ma, see Yum pa (2006: 104): Lcang skya'i Yongs 'dzin Ja sag Bla ma Or tu su (< M. Urdus) Zhabs drung Blo bzang bstan 'dzin nyi ma is the author of the *Blo gsal 'dod 'jo* which changed the epoch of Sum pa Mkhan po's *bu gzhung* into 1867. Given the epoch, 'Lcang skya ho thog thu' seems to be the Lcang skya V Ye shes bstan pa'i nyi ma (1849-1874). Because I do not have information on both the 'Lcang skya' and Blo bzang bstan 'dzin nyi ma, I leave this issue open. For the text *Rab gsal me long*, see Mi pham (2012a: 259-62). The eopch is 1867. Given the same *rtsis 'phro* with the *Dga' ldan rtsis gsar*, it is highly possible that it is one of the *Dga' ldan rtsis gsar* texts. For the author, see Mi pham (2012a: 262): "There is *mdzad byang* (author's colophon) stating that Ngag gi dbang po wrote [it.]" (*ngag gi dbang pos bsdebs zhes mdzad byang 'dug /*). At present, we cannot identify him. Čaqar Dge bshes, A kyā Yongs 'dzin Ngag dbang nyi ma (?- 1794 ?) who wrote the *Nyi ma'i 'od zer*, and U cu mu min (*sic.* < M. Üǰümčin) Zhabs drung 'Jam dpal dgyes pa'i rdo rje (?-?) who wrote the *Me tog chun po* (epoch: 1846) are also classified as the *Dga' ldan rtsis gsar* adherents in Yum pa (2006: 104). Also, see Yum pa's introduction to Gser tog, which is included in Gser tog (2015) (not available to me as of March, 2016) for the history of the *Dga' ldan rtsis gsar.* I speculate that the lamas mentioned here are ethnically Mongolian.

[585] Mi pham (2012b) is critical of all the different systems in *skar rtsis* from earlier *Phug* system to contemporary Rnga ban Kun dga', which involve the change of *rtsis 'phro* for accurary in eclipse calculation, and concludes that there is no reliable *skar rtsis* system for eclipse calculation.

fragmentary ideas on *rtsis 'phro*, such as the relationship between *skar rtsis* and the Chinese calendar/*rgya rtsis*, his astronomical observations, function of empirical knowledge, and his *rtsis 'phro* corrections and their effect of *rtsis 'phro* corrections, etc.. Fundamentally, I should admit that there is not a great deal of materials to argue these issues in the system of the *Dga' ldan rtsis gsar* in particular and in the *Phug* systems in general. Next, let me propose a fundamental question to conclude this section: The main difference between the *Dga' ldan rtsis gsar* and the *Pad dkar zhal lung* is the *rtsis 'phro* difference. This means that in Sum pa Mkhan po's conception, the fallacy of an astronomical system is caused by *rtsis 'phro*. If it is so, is his thinking correct? Does he not cast doubt upon this idea?

On the issue of *rtsis 'phro* and eclipse calculations, more explanation, or the repetition or overlap, of the explanation of the agreement between *rtsis* and visible phenomena will be given below in the section of *stong chen 'das lo*, because this concept is coupled with *rtsis 'phro*, but with a larger scheme including all planets except for *du ba mjug ring*. Basically, the *Kālacakra* / *skar rtsis* diagnosis and solutions for accurate eclipse calculations from *nur ster*, *rtsis 'phro* and *stong chen 'das lo* concern the differentiation of longitude.

1.2.3. CORRECTION OF ELASPED YEARS FROM A GREAT CONJUNCTION AT THE ZERO POINT (T. *STONG CHEN 'DAS LO*)

GREAT CONJUNCTION (*STONG CHEN*/ *STONG CHEN 'DAS LO*)

The Great Conjunction is an event where the planets are aligned. Its equivalent concept in Tibet is *stong chen* / *stong chen lo tshogs* of Indic origin: Petri showed the textual basis in the *Laghukālacakra* I. 88-89. [586] Schuh also pointed this out: "Diese Idee der grossen Konjunktion aller Planeten war dem tibetischen Astronomen aus dem *Kālacakratantra* bekannt."[587] The relevant concept is *stong 'jug* (entry into vacuity) as described by Schuh "... der Gedanke eines Ausgangspunktes für die Kalkulationen, für den alle Anfangswerte gleich Null zu setzen sind, ..." [588] The concept is also related to epoch value. Tibetans customarily change epoch (*rtsis 'go spos pa*) every 60 years.[589]

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[586] Petri (1966: 38-44, especially 40).

[587] Schuh (1973a: 103).

[588] Schuh (1973a: 99).

[589] Kong sprul Blo gros mtha' yas, tr. 'Gyur med rdo rje (2012: 348): "Concerning the timing of this entry into [the state of] vacuity (*stong 'jug*), ... at the end of the solar mansion Pisces (*nya khyim*), on the thirtieth day of the month of *Phālguna* (*dbo zla ba*), in the fire-tiger year [which is the last year of the sexagenary cycle], the exact longitude (*longs spyod rnam par dag pa*) of the planets and constellations is conventionally designated as an "entry into vacuity". Then, once again from the first day of the month of caitra (*nag zla*) in the [fire-hare] year of *prabhāva* (*rab byung*), [which is the first year of the next sexagenary cycle], the mean longitudinal positions (*rtag pa'i longs spyod*) pertaining to all the years, months, planets, and constellations newly arise."

There must have been discussions and debates over the issue of *stong chen* / *stong 'jug* even before the *Phug* tradition tackled it in earnest, but especially in the *Phug* system, it is a pivotal and crucial topic in terms of accuracy of an astronomical system.[590]

> … schlechthin für alle Anfangswerte aller Kalkulationen der Kalenderrechnung und der Astronomie der Betrag 0 gegeben sein soll. Die Periode des Eintreffens dieser groβen Konjunktion, nämlich 4320000 Jahre, konnte in Tibet nicht akzeptiert werden, da sie sich aus den numerischen Gegebenheiten der *skar rtsis* nicht ableiten lieβ.[591] Dies spricht Sangs rgyas rgya mtsho im *Vaiḍūrya dkar po* auch offen aus, und er gibt zugleich als Periode für die groβe Konjunktion nach der *grub rtsis* die phantastische Zahl von 279623511548502090600 Jahren an.[592] Die letzte groβe Konjunktion hat nach dem

[590] For example, the letter exchanges between Byang bdag and Mkhas grub clearly show their understanding of the *Laghukālacakra* and *Vimalaprabhā* chapter I, verse 88, in which *stong chen*/ *stong 'jug* is mentioned together with their astronomical points of view. Byang bdag supports the *grub rtsis*, meanwhile Mkhas grub supports the *byed rtsis* in terms of *stong 'jug* calculation. See Mkhas grub (1897a: 763 ff) and Byang bdag (1) (n.d.: 65b ff): Mkhas grub uses *byed rtsis* for the calculation of *stong 'jug*. Byang bdag does not raise a strenuous objection. Byang bdag (1) (n.d.: 65b-66a): "Also, if you agree with the way of planets's entry into vacuity (T. *stong pa la 'jug pa*) by adhering a little while to the exposition of the *byed rtsis* known as common to non-buddhists (T. *phyi rol.* My reading is *phyi rol pa*), without being based upon the fine exposition of the extraordinary *grub mtha'*, … is compatible with the *dgongs pa* in the *Kālacakra* (T. *Rgyud kyi rgyal po*) and is as you said." (*yang khyed kyis thun mong ma yin pa grub mtha'i rtsis kyi dbang du byas pa'i rnam bzhag zhib mo ma yin par / phyi rol dang thun mong du grags pa'i byed rtsis kyi rnam bzhag la re zhig gnas nas gza' rnams stong pa la 'jug pa'i tshul dang bstun pa na / … rgyud kyi rgyal po'i dgongs pa dang mthun zhing / khyed kyis ji ltar bshad pa ltar lags /*).

[591] For the great conjuction in Indian astronomy, there is much research; see Varāhamihira, tr. Burgess (1977: introduction ix ff.), Billard (1971), van der Waerden (1980). Van der Waerden (1987: 529-34): Āryabhaṭa's (476-550) *śīghra* and *manda* motions of planets during the *mahāyuga* period are explained. Most of all, for the conceptual frame of the *mahāyuga* year 4320000, see Brahmagupta (7th c.), tr. Sengupta, (1934: xi, especially, 39-47): the relationship between the the revolutions of each planet in the *mahāyuga* year and the daily motion of each planet is well explained in an Indic context.

[592] Schuh's (1973a: 103) figure 279623511548502090600 is incorrect. It seems to be a typing mistake which is repeated in Schuh (2012a: 109-10). The correct value of the *Stong chen lo tshogs* is 279623511504850209 0600.

> *Vaiḍūrya dkar po* rückgerechnet vom Beginn der *nag* Monats des Jahres 1687 vor 82776132766945179600 Jahren stattgefunden. ....[593]

As clarified in the above passage, the *stong chen lo tshogs* calculation is based upon an astonishing arithmetic understanding of the planetary periods as described in the Tibetan astronomical texts.[594]

The following section presents how the terms *stong chen*/ *stong chen lo tshogs* are calculated by using Bsam ’grub rgya mtsho (1992: 188). Subsequently, the *stong chen las ’das lo* (simply *stong chen ’das lo.* elapsed years from a Great Conjunction at the Zero Point) combined with *rtsis ’phro* is related to the issue of eclipse calculation. Bsam ’grub rgya mtsho presents the following table which is difficult to understand because there is no explanation. It is based on *khyim lo*. It is also calculation based, not theory based, which is clarified below. Basic knowledge of the idea of *zhag gsum rnam dbye* and period (cycle) is necessary to understand how the numbers are calculated. In it, *zla rkang* means *ril cha* (lunar anomaly), *gza’ tshes* means the value related to *gza’ dhru* (weekday).

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[593] Schuh (1973a: 103). For the textual evidence in the *Vaiḍūrya dkar po*, see the Sde srid (1996: 213): 82776132766945179600 (1687’s (*Vaiḍūrya dkar po*’s epoch) *stong chen ’das lo*). And *stong chen ma ’ongs lo tshogs* is also given in the Sde srid (1996: 215): 2796235115048502090600 – 82776132766945179600 = 2713458982281556911000 .

[594] For an excellent explanation of the periods of the planets in the *Phug* tradition, see Brag dgon Zhabs drung (epoch: 1987. original epoch: 1867) (2006: 1329-43). [= Brag dgon Zhabs drung (1987a: 52b-67a)]. For a summary, see Blo bzang dpal ldan (1990: 256-65), Bsam ’grub rgya mtsho (1992: 188-90).

Table 37.

	nyi ma'i zhag gsum mthun lo sgyur byed ⓐ (times)	*so so'i zhag gsum mthun lo* ⓑ (*khyim lo*)	*rang rang zhag mthun sgyur byed* ⓒ (times)	*drug cu'i skor mthun dag lo* ⓓ (*khyim lo*)
Sun (Nyi ma)	1	65	12	780
zla rkang (*ril cha*)	294	19110	2	38220
gza' tshes (*res gza'/ gza'*)	9898	643370	6	3860220
Sgra gcan (Rāhu)	115	7475	12	89700
Mars (Bkra shis / Mig dmar)	323806	21047390	6	126284340
Jupiter (Phur bu)	2041816	132718040	3	398154120
Saturn (Spen pa)	15223124	989503060	3	2968509180
Venus (Pa sangs)	1059086	68840590	6	413043540
Mercury (Lhag pa)	12438958	808532270	6	4851193620

The basic ideas are as follows. ⓑ = ⓐ × 65, ⓓ = ⓑ × ⓒ. For example, in the case of the sun in ⓑ, 65 means that the *nyi dhru* value becomes 0, i.e. $0^{k}0^{q}0'0''0'''$ every 65 years. For example, the *nyi dhru* value at 1987/3/0 (according to the *Pad dkar zhal lung grub rtsis*) is $0^{k}0^{q}0'0''0'''$, the *nyi dhru* value at 1922/3/0 is $0^{k}0^{q}0'0''0'''$[595] . There is a 65 year difference between the two. From ⓒ, *ches chung ba'i spyi'i ldab grangs* (least common multiple) should be understood.[596] In the column of ⓒ, the reason why multiply 12, 2, 6, 12, 6, 3, 3,

[595] The *grub rtsis* values of the *Pad dkar zhal lung* at 1922/3/0 are as follows: *gza' dhru* $4^{z}35^{q}56'2''434'''$, *ril cha* 3/42, *nyi dhru*: $0^{k}0^{q}0'0''0'''$.

[596] Any modern dictionary of mathematics will explain it. For a modern Tibetan work, see *Bod yig gi grangs rig tshig mdzod* (1999: 219-20).

6, 6 respectively is that they are the minimum integers that make each quotient become an integer when the values of ⓓ are divided by 60. In other words, 65 × 1 = 65, 65 × 2 = 130, 65 × 3 = 195, 65 × 4 = 260, 65 × 5 = 325, 65 × 6 = 390, 65 × 7 = 455, 65 × 8 = 520, 65 × 9 = 585, 65 × 10 = 650, 65 × 11 = 715, 65 × 12 = 780. When dividing the results by 60, the quotient is not an integer until 780. Therefore, the least multiple 12 is multiplied. Note again that 60 years are used customarily because of the *rab byung* system. The subsequent table is calculated on a month (*tshes zla*) basis.[597]

Table 38.

	zhag mthun khyim zla ⓔ (= ⓑ × 12)	*zhag mthun tshes zla* ⓕ[598]	*'khor grangs* (times)[599]
Nyi ma	780	804 (= **804** × 1)	65 (= **65** × 1)
zla rkang	229320	236376 (= **3528** × 67)	16951 (= **253** × 67)
gza' tshes	7720440	7957992 (= **39592** × 201)	1740057 (= **8657** × 201)[600]
Sgra gcan	89700	92460 (= 230 × 402)	402 (= 1 × 402)
Bkra shis	252568680	260340024 (= 1295224 × 201)	11190675 (= 55675 × 201)
Phur bu	1592616480	1641620064 (= 8167264 × 201)	11190675 (= 55675 × 201)
Spen pa	11874036720	12239391696 (= 60892496 × 201)	33572025 (= 167025 × 201)
Pa sangs	826087080	851505144 (= 2118172 × 402)	111906750 (= 278375 × 402)
Lhag pa	9702387240	10000922232 (= 12438958 × 804)	3357202500 (= 4175625 × 804)

[597] See Bsam 'grub rgya mtsho (1992: 188).

[598] See also Pa sangs lhun grub and Nor bu tshe ring (1998: see especially 125).

[599] For a understanding of how each *'khor grangs* is calculated, see above notes 464, 466, 468. It depends on the *tshes zla longs spyod* of each planet.

[600] I indicated the values of *tshes zla'i dkyil'khor* and *'khor grangs* of *nyi ma, ril cha* (*zla rkang*), and *gza' tshes* (*gza'*) in boldic. For these, see Bsam 'grub rgya mtsho (1992: 57-91) which was used on pp 216-23.

ⓕ = ⓔ × $\frac{67}{65}$ = ⓐ × 804. The numbers in the column of ⓕ are multiples of 67.

The *stong chen lo tshogs* calculation (*khyim lo* based calculation) is the procedure to find the least common multiple for all the periods. The following tables are given by Bsam 'grub rgya mtsho. *Du ba mjug ring* is excluded out of 10 planets.[601]

Table 39.

The table showing the calculation method of the year in which the planets are purified (T. *dag pa*) gradually together (*gza' rnams rim bzhin lhan tu dag pa'i lo btsal tshul gyi re'u mig*)		
Nyi ma	Sgra gcan	Bkra shis
65	3860220	443925300
60	89700	126284340
5	3120	65072280
(12)	2340	61212060
ril cha	780	3860220
780	**115**	3308760
38200		551460
49		**229**
gza' tshes		
38200		
3860220		
101[602]		

[601] Generally, ten planets exist in the Tibetan tradition. The reason why the *du ba mjug ring* is excluded is that its movement is consistent with the movement of the sun. For example, Sum pa Mkhan po (1979c: 10a): "I think that [the movement of] the *du ba* is seen, being consistent with the movement of the sun: at the time of its rise, its peak is shown over there from the sun (= seen from the same direction with the sun), and its length also depends on the distance to the sun, and ...". (... *du ba de nyi ma'i 'gros dang mthun par mthong ngam snyam ste / de 'char tshe rtse mo nyi ma las phar ston pa dang / ring thung yang nyi ma la nye ring gis yin pa dang / ...* .). Also see Bsam 'grub rgya mtsho (2011: 105).

[602] The result of 780, 49, 101 is as follows: consider the following two conditions: multiple of 60 and minimum number. $38200 \div 780 = 49$. $3860220 \div 38200 = 101$. See also Blo bzang dpal ldan (1990: 263-4).

Table 40.

Phur bu	Spen pa	Pa sangs	Lhag pa
101658893700	73317721251400	56442847642326600	6039384697728946200
398154120	2968509180	413043540	4851193620
129593100	1331775900	162129240	3080455560
1374820	304957380	88785060	1770738060
7720440	111946382	73344180	1309717500
1654380	81064620	15440880	461020560
1102920	30881760	11580660	387676380
551460	19301100	3860220	73344180
722	11580660	**107**	20955480
	7720440		10477740
	3860220		**463**
	769		**2796235115048502090600**

The calculations are as follows:

Sgra gcan

$3860220 = 89700^{603} \times 43 + 3120$

$89700 = 3120 \times 28 + 2340$

$3120 = 2340 \times 1 + 780$

$2340 = 780 \times 3 + 0$

$\underline{89700 = 780 \times \mathbf{115}}$

$(3860220, 89700) = 115$

Bkra shis

$443925300^{604} = 126284340^{605} \times 3 + 65072280$

$126284340 = 65072280 \times 1 + 61212060$

---

[603] 89700 is obtained in the following way:

$\frac{\mathbf{230 \times 402}}{\mathbf{804}} = 115.$

$115 \times 65 = 7475.$

$7475 \times 12 = 89700$ year .

See Blo bzang dpal ldan (1990: 259).

[604] $3860220 \times 115 = 443925300.$

[605] 126284340 is obtained in the following way:

$323806 \times 65 = 21047390$

$21047390 \times 6 = 126284340$

See Blo bzang dpal ldan (1990: 260-1).

$65072280 = 61212060 \times 1 + 3860220$
$61212060 = 3860220 \times 15 + 3308760$
$3860220 = 3308760 \times 1 + 551460$
$3308760 = 551460 \times 6 + 0$
$\underline{126284340 = 551460 \times \mathbf{229}}$
$(443925300, 126284340) = 229$

Phur bu
101658893700[606] $= 398154120$[607] $\times 255 + 129593100$
$398154120 = 129593100 \times 3 + 1374820$
$129593100 = 9374820 \times 94 + 7720440$
$9374820 = 7720440 \times 1 + 1654380$
$7720440 = 1654380 \times 4 + 1102920$
$1654380 = 1102920 \times 1 + 551460$
$1102920 = 551460 \times 2 + 0$
$(101658893700, 398154120) = 551460.$
$101658893700 = 551460 \times 184326$
$\underline{398154120 = 551460 \times \mathbf{722}}$
$(101658893700, 398154120) = 722$

Spen pa
73317721251400[608] $= 2968509180$[609] $\times 24725 + 1331775900$
$2968509180 = 1331775900 \times 1 + 304957380$
$1331775900 = 304957380 \times 1 + 111946380$
$304957380 = 111946380 \times 2 + 81064620$
$111946380 = 81064620 \times 1 + 30881760$
$81064620 = 30881760 \times 2 + 19301100$
$30881760 = 19301100 \times 1 + 11580660$

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[606] $443925300 \times 229 = 101658893700$.

[607] 398154120 is obtained in the following way:
$2041816 \times 65 = 13272090$.
$13272090 \times 3 = 398154120$.
See Blo bzang dpal ldan (1990: 261).

[608] $101658893700 \times 722 = 73317721251400$.

[609] 2968509180 is obtained in the following way:
$15223124 \times 65 = 989503060$
$989503060 \times 3 = 2968509180$
See Blo bzang dpal ldan (1990: 262).

19301100 = 11580660 × 1 + 7720440
11580660 = 7720440 × 1 + 3860220
7720440 = 3860220 × 2 + 0
<u>2968509180 = 3860220 × **769**</u>
(73317721251400, 2968509180) = 769

Pa sangs
56442847642326600[610] = 413043540[611] × 136651084 + 162129240
413043540 = 162129240 × 2 + 88785060
162129240 = 88785060 × 1 + 73344180[612]
88785060 = 73344180 × 1 + 15440880
73344180 = 15440880 × 4 + 11580660
15440880 = 11580660 × 1 + 3860220
11580660 = 3860220 × 3 + 0
<u>413043540 = 3860220 × **107**</u>
(56442847642326600, 413043540) = 107

Lhag pa
6039384697728946200[613] = 4851193620[614] × 1244927572 + 3080455560
4851193620 = 3080455560 × 1 + 1770738060
3080455560 = 1770738060 × 1 + 1309717500
1770738060 = 1309717500 × 1 + 461020560
1309717500 = 461020560 × 2 + 387676380
461020560 = 387676380 × 1 + 73344180

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[610] 73317721251400 × 769 = 56442847642326600 .

[611] 413043540 is obtained in the following way:
1059086 × 65 = 68840590
68840590 × 6 = 413043540
Blo bzang dpal ldan (1990: 262).

[612] It was incorrectly scribed as 7344180 in Bsam ’grub rgya mtsho (1992: 189).

[613] 56442847642326600 × 107 = 6039384697728946200 .

[614] 4851193620 is obtained in the following way:
12438958 × 65 = 808532270
808532270 × 6 = 4851193620
Blo bzang dpal ldan (1990: 263).

$387676380 = 73344180 \times 5 + 20955480$
$73344180 = 20955480 \times 3 + 10477740$
$20955480 = 10477740 \times 2 + 0$
$\underline{4851193620 = 10477740 \times \mathbf{463}}$
$(6039384697728946200, 4851193620) = 463$

Finally, the *stong chen lo tshogs* = $780 \times 49 \times 101 \times 115 \times 229 \times 722 \times 769 \times 107 \times 463 =$ 2796235115048502090600 *khyim lo*.[615]

In Tibetan tradition, besides *stong chen lo tshogs, stong chen las 'das lo*, which reflects *rtsis 'phro* at the epoch of each tradition, is also calculated.[616] The *stong chen las 'das lo* value of each of the traditions belonging to the *Phug* school whose epoch is 1987/3/0 is given in Bsam 'grub rgya mtsho (1992) by the following[617]:

Table 41.

Stong chen lo tshogs
2796235115048502090600[618]

[615] See Bsam 'grub rgya mtsho (1992: 187). Kun dga' rig 'dzin and Phur bu don grub (1998: 176-209).

[616] Yum pa (2006: 139).

[617] See Bsam 'grub rgya mtsho (1992: 190). I do not know how to calculate the value particular to each tradition. Future research is needed.

[618] See Nor bzang rgya mtsho (1980: 17a) [= Nor bzang rgya mtsho (2002: 434)].

Table 41 (continued)

Stong chen 'das lo in 1987[619]	
Pad dkar zhal lung	82776132766945179900
Mkhas pa'i snying nor	173018324949111377100
Dga' ldan rtsis gsar	894592876762834614600
Yang gsal sgron me [= Go shrī (1767)]	716963718294274361760
Yang gsal sgron me [= Go shrī (1770)]	157787943639903178200

In the case of the *Yang gsal sgron me*, two different values caused by the differences of the *rtsis 'phro*-s are given.

Sum pa Mkhan po's explains how his *stong chen 'das lo* was created in the second letter to Ngag dbang nyi ma in 1785/1786.

> *... gtsang chung chos grags rgya mtsho'i* (supralinear note: 1) *slob ma phugs* (*sic.* read *phug*) *pa lhun grub rgya mtsho* (supralinear note: 2) *dang rje nor bzang rgya mtsho* (supralinear note: 3) *rnam gnyis kyi dus 'khor rtsa rgyud kyi dgongs pa ltar du lung rigs kyis dpyad de sa gzhung* (*sic.* read *gzhong*) *la sa ris tsam bris nas stong chen gsum ...* (illegible) *legs pa byung nas rtsis 'phro bzhag te zhal lung ma bu bkod la / ... de rjes su kho bos kyang de dag ji bzhin du ...* (illegible) *lo tsam spos pa'i ma gzhung bkod par... / ... bu'i rtsa ba stong chen lan gcig btsal bas ...* (illegible) (sublinear note: 3 ?) *gza' 'ga' re'i 'gro ba ri mo dang mig mthong ma 'grigs pas / slar yang gcig btsal kyang ...* (illegible) *gnyis kyi 'gros ma dag pas / slar gsum pa btsal nas lnga sgra gza' lnga'i 'phro gtsang dang bsreg bcad brdar ba'i gser bzang ltar du byung pas rang lugs thun mong min pa bzhag la... / de lta'i byed rtsis dang grub rtsis gsar rnying gsum po gser dngul ra gan ltar mi 'dra ba ni / rtsis 'phro mi 'dra ba'i dbang gis yin pas / grub rnying dang byed pa'i bar la zhag*

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[619] The values given by Bsam 'grub rgya mtsho (1992: 190) are those of the *stong chen 'das lo* in 1987. In the case of the *Pad dkar zhal lung*, see Nor bzang rgya mtsho (1980: 17a-17b) [= (2002: 434)]: 82776132766945179399 is the value for the year 1486 (epoch: 1447 C.E.). 82776132766945179900 – 82776132766945179399 = 501 years, i.e. 82776132766945179900 = 1987's value. In the case of the *Mkhas pa'i snying nor*, see Thu'u bkwan III (2000: 27b): 173018324949111375919 is the value for the year 806 (the epoch: 1796 C.E.) 173018324949111377100 – 173018324949111375919 = 1181 years, i.e. 173018324949111377100 = 1987's value. In the case of the *Dga' ldan rtsis gsar*, see Sum pa Mkhan po as edited in Yum pa (2015a: Pdf 278): 894592876762834614360 is the value for 1747 (the epoch). 894592876762834614600 – 894592876762834614360 = 240 years, i.e. 894592876762834614600 = 1987's value. In the case of the *Yang gsal sgron me*, see Go shrī (1767: *ka*, 19 *gong* [= 1 *ben* (本) *shang* (上) 19]): 716963718294274361520 is the value for the year 1747 (the epoch). 716963718294274361760 – 716963718294274361520 = 240 years, i.e. 716963718294274361760 = 1987's value. In the case of Go shrī (1770: *ka* 18b [= 1 *ben* (本) *xia* (下) 18): 157787943639903177960 is the value for the year 1747 (the epoch). 157787943639903178200 – 157787943639903177960 = 240 years, i.e. 157787943639903178200 = 1987's value.

brgyad lhag dang (supralinear note: 12) / *rtsis gsar dang phugs* (*sic.* read *phug*) *lugs bar la drug* (supralinear note: 12?) *lhag dang byed pa'i bar la gcig* (supralinear note: 12?) *lhag gi* ... (illegible) *khyad yod pas / de gsum dper na mdo sems dbu ma pa so so'i lugs mi 'dra ba ltar ro /*[620]

Gtsang chung Chos grags rgya mtsho's students Grwa phug pa and Nor bzang rgya mtsho examined by scripture and reasoning according to the intention of the *Kālacakramūlatantra*, calculated arithmetic with sand abacus, and then the three *stong chen* (= *stong chen 'das lo*) ... having appeared, [they] put *rtsis 'phro* and composed the *Pad dkar zhal lung* and its son-texts (Nor bzang rgya mtsho's texts). ... After that, I also composed the mother-text (= *Skar nag rtsis kyi snying nor nyung 'dus kun gsal me long*) which changed only the year [of epoch] according to them ... . [I calculated] the *stong chen* (= *stong chen 'das lo*), the basis of the son-text (= *Zla bsil rtsi sbyor dge ldan rtsis gsar*), one time, ... the values did not agree with the observations in the case of the individual movements of some planets. So, [I] calulated [the *stong chen 'das lo*] again, ... the movements of the two ... are not accurate. So, [I calculated] again for the third time, and the *rtsis 'phro* values of *lnga bsdus*, *sgra gcan*, *gza' lnga* emerged like the best gold which was purified, burned, cut, and polished. That way, my own extraordinary tradition was created. *...* .[621] Because the dissimilarity of the three, *byed rtsis* and new and old *grub rtsis*-s[622] like gold, silver, and brass is due to the difference of *rtsis 'phro*, there are differences ... more than 8 days between the old *grub rtsis* and *byed rtsis*, more than 6 days between the *Dga' ldan rtsis gsar* and the *Phug* tradition, more than one day between *Dga' ldan rtsis gsar* and *byed rtsis*. Therefore, [the differences of] the three, for example, are like the differences of the individual tradition, *mdo sde pa* (S. *sautrāntika*), *sems tsam pa* (S. *vijñānavādin*), and *dbu ma pa* (S. *mādhyamika*).

[620] Sum pa MKhan po (1979c: 91a).

[621] A similar account is found in Mi pham (2012a: 263). For Sum pa Mkhan po's own statement about the creation of the *Dga' ldan rtsis gsar*, see Sum pa Mkhan po (1979d: 119a) [= Sum pa Mkhan po (2001: 310)]: "When composing this original text of the *Dga' ldan rtsis gsar* (on top of these (= the three values) after having sought three *stong 'jug* values), which placed my extraordinary tradition, with a stroke of a brush (T. *nag 'gros*), obtaining one difficult value, which did not come out, also occurred in my dream ...". (*... rang lugs thun mong ma yin pa bzhag pa'i dge ldan rtsis gsar gyi ma mo 'di nag 'gros* (*stong 'jug gsum btsal nas dag steng* (*sic.* maybe *de dag gi steng*)) *lta bur sgrig skabs su de'i ri mo dka' ba zhig ma thon pa rmi lam du rnyed pa'ang byung bas ...* /). He must have devoted a lot of time and energy to figuring out the *stong chen* values to the degree that they appeared in his dream. Another similar account is seen in Sum pa Mkhan po (1997: 82): (*lo der rang lugs bzhag pa'i dge ldan rtsis gsar bsgrigs skabs su ri mo dka' shos 'ga' zhig ma song ba rmi lam du rnyed pa byung ba'ang ...* .). "When composing the *Dga' ldan rtsis gsar*, which placed my own tradition, in the year (1754 C.E.), obtaining some most difficult values, which did not come, occurred in the dream, ..."

[622] In this context, *grub rtsis gsar rnying* means this: *grub rtsis gsar ma* is the *Dga' ldan rtsis gsar*, *grub rtsis rnying ma* is the *Pad dkar zhal lung.* I am not sure whether the term has been commonly used in such a way in Tibetan academy.

Sum pa Mkhan po found his own *stong chen 'das lo* like Grwa phug pa calculated three times, which may mean that the former tried to find the three values of the latter to gain a mastery of the method of calculating the *stong chen 'das lo*. Unfortunately, we do not have them any more. We just have the final value in both Sum pa Mkhan po and Grwa phug pa.

As mentioned above, the *rtsis 'phro* difference is reflected in the *stong chen 'das lo.* What does this mean? More in-depth research is necessary. However, my current findings on the relationship between *rtsis 'phro* and *stong chen 'das lo* are as follows: *rtsis 'phro*-s are computed from the *stong chen 'das lo*. The *stong chen 'das lo* $\times 12 \times \frac{67}{65} =$ *zla dag*. After that, the normal calculations, e.g. calculations of *gza' dhru*, *ril cha*, *nyi dhru*, etc. sequentially, are followed. Since the *stong chen 'das lo* has too many digits, it is difficult to calculate with *sa gzhong*. Meanwhile, the calculations using *rtsis 'phro* at a certain epoch are easy. To illustrate, Blo bzang dpal ldan (1880/1881-1944) presents: 157787943639903178155 (*chu rta*; 1942 C.E.), Go shrī's (1770) *stong chen 'das lo* value at 1942/3/0, is incorrectly given as that of the *Dga' ldan rtsis gsar*.[623] Anyway, in this case, *zla dag* $=$ 195171548748434084979 4. *mda' ro lhag ma* $=$ 10. *gza' 'dhru 'phro*: $4^{z}41^{q}46'3''27'''$[624].

[623] In addition, the quantity itself is also wrongly given in Blo bzang dpal ldan (1990: 265): 157787943633903178155 is incorrect.

[624] Blo bzang dpal ldan (1990: 265-6). The calculations are as follows: A million digit calculator (http://comptune.com/calc.php) was used and the numbers were rounded off to the nearest millions (6 decimal places).

$1951715487484340849794 \div 39592 = 49295703361394747.671095$.

$0.671095 \times 39592 = 26570$.

$26570 \times 8657 \div 39592 = 5809.670893$ ($230016490 \div 39592 = 5809 +$ remainder 26562).

In another example, *Phug pa grub rtsis* at 1942/3/0: *stong chen 'das lo* 82776132766945179855[625] *zla dag* = 1023877088378829609283, *mda' ro lhag ma* = 25, *gza' 'dhru 'phro*: $4^{z}39^{q}$14'2"218"'[626] . Lastly, *stong chen ma 'ongs lo tshogs* = *stong chen lo tshogs* – *stong chen 'das lo*.[627]

5809.670893 – 5809 = 0.670893 .
0.670893 × 7 = **4.**696252 (26562 ÷ 39592 × 7 = 4 + remainder 27566).
4.696252 – 4 = 0.696252 .
0.696252 × 60 = **41.**775106 (27566 ÷ 39592 × 60 = 41 + remainder 30688).
41.775106 – 41 = 0.775106 .
0.775106 × 60 = **46.**506365 (30688 ÷ 39592 × 60 = 46 + remainder 20048).
46.506365 – 46 = 0.506365 .
0.506365 × 6 = **3.**038190 (20048 ÷ 39592 × 6 = 3 + remainder 1512) .
3.038190 – 3 = 0.038190 .
0.038190 × 707 = **27** (1512 ÷ 39592 × 707 = **27**) .

[625] The *stong chen 'das lo* is incorrectly given in Blo bzang dpal ldan (1990: 266): 8277613276694519855 is incorrect.

[626] Blo bzang dpal ldan (1990: 266). 1023877088378829609283 ÷ 39592 = 25860706414902748.264372 .
0. 264372 × 39592 = 10467
10467 × 8657 ÷ 39592 = 2288.664857 (10467 × 8657÷ 39592 = 2288 + remainder 26323).
2288.664857 – 2288 = 0.664857 .
0.664857 × 7 = **4.**653996 (26323 ÷ 39592 × 7 = 4 + remainder 25893).
4.653996 – 4 = 0.653996 .
0.653996 × 60 = **39.**239745 (25893 ÷ 39592 × 60 = 39 + remainder 9492).
39.239745 – 39 = 0.239745 .
0.239745 × 60 = **14.**384724 (9492 ÷ 39592 × 60 = 14 + remainder 15232).
14.384724 – 14 = 0.384724 .
0.384724 × 6 = **2.**308345 (15232 ÷ 39592 × 6 = 2 + remainder 12208).
2.308345 – 2 = 0.308345 .
0.308345 × 707 = **218** (12208 ÷ 39592 × 707 = remainder 218).

[627] In the case of the *Pad dkar zhal lung*, the value is 2713458982281556911201 = 2796235115048502090600 – 82776132766945179399. See Nor bzang rgya mtsho (1980: 17b) [= (2002: 434-5)].

RELATIONSHIP BETWEEN *STONG CHEN* AND ECLIPSE CALCULATION

Go shrī (1767) explains the relationship between the corrections of *rtsis 'phro* / *stong chen 'das lo* and the accuracy of eclipse calculations.

> *... padma dkar po'i zhal lung du / gsungs pa'i nyi ma'i rtsis 'phro ni / nyung bas gza' 'dzin la sogs la / mi 'grig lta bur snang ba'i phyir / stong chen lo tshogs las btsal te / nyi ma'i chu tshod nyi shu lhag / rtsis 'phro gzhan rnams snga ma dang / mthun pa 'tshol te bkod pa 'di'i / stong chen 'das pa'i lo tshogs ni / mkha' mig tshes dus me chu ri / lag mtsho bug mig nor zla thub / me mtshams gter rgyan gzugs ri ste* (supralinear note: 716963718294274361520) */... stong chen ma 'ongs lo tshogs ni / mkha' klu thig gter mig ri thub / lag zung chu dbang gza' dus bug / 'dod pa 'khor lo bug ri mkha' / mig ste ... / stong chen 'das pa'i lo tshogs las / rtsis 'phro spo bar res gza' yi / dkyil 'khor mig bug mda' rtsa me* (supralinear note: 39592) */ ril cha'i klu lag 'byung me* (supralinear note: 3528) *dang / nyi ma'i dkyil 'khor chu mkha' klu* (supralinear note: 804) */ sgra gcan zla ril mkha' me lag* (supralinear note: 230) */ zla phyed mkha' dus chu* (supralinear note: 460) *yin no / ...* [628]

Go shrī's (1767) Table A1.

8657	*gza'*	39017
253	*ril cha*	3345
65	*nyi ma*	309
'khor grangs[629]		*rtsis 'phro*

The one that ... [I] calculated from the *stong chen lo tshogs*, [increased] more than 20 *chu tshod* in [the *rtsis 'phro*] of the sun, and sought the other *rtsis 'phro*-s which agree with (did not change from) the previous one (= *Pad dkar zhal lung*) because such things that eclipse, etc. do not agree appear, due to the *rtsis 'phro* of the sun stated in the *Pad dkar zhal lung* being small: The *stong chen 'das lo* of this text [created that way. the epoch is 1747] is 716963718294274361520.[630] ... *Stong chen ma 'ongs lo tshogs* is 2079271396754227729080 (= 2796235115048502090600 (*stong chen lo tshogs*) − 716963718294274361520 (*stong chen 'das lo*)). ... For the change of the *rtsis 'phro* from the *stong chen 'das lo*, the planetary period (*res gza' yi dkyil 'khor*) is 39592 [*tshes zla*], the *ril cha* is 3528 [*tshes zla*], the period of the sun (*nyi*

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628 Go shrī (1767: *ka*, 19 *gong*-20 *gong* [= 1 *ben* (本) *shang* (上) 19-1 *ben shang* 20]).

629 For the values, which are common to the *Phug* traditions with different *stong chen 'das lo*-s, see also Bsam 'grub rgya mtsho (1992: 57-91). See also above pp. 215ff. The values of the period are common to the *Phug* traditions including *Dga' ldan rtsis gsar*, *Mkhas pa'i snying nor*, etc..

630 This shows that this text was written in 1767 C.E..

> *ma'i dkyil 'khor*) is 804 [*tshes zla*], the period of Rāhu (*sgra gcan* [*gyi dkyil 'khor*]) is 230 months (*tshes zla*) and is 460 half months (*tshes zla*).

In this passage, i.e. as of 1747/3/0 (epoch), the *zla dag* = 886828968474763979480I, *stong chen ma 'ongs lo tshogs*: 2079271396754227729080 = 2796235115048502090600 – 716963718294274361520. *gza' 'dhru'i 'phro*: $1^{z}54^{q}44'5''437'''$, *ril cha'i 'phro*: 24/69, *nyi dhru'i 'phro*: $26^{k}29^{q}46'3''27'''$.[631] From the above passage, it is clear at least in the case of Go shrī that the *stong chen 'das lo* corrections (basically the same with *rtsis 'phro* correction) were made for an accurate eclipse calculation. As seen in the previous section, Sum pa Mkhan po also believed so. It may be assumed that Tibetans believed that the *rtsis 'phro* / *stong chen 'das lo* corrections contribue to accuracy for eclipse calculation.

1.2.4. A COMPREHENSIVE VIEW: *SKAR RTSIS* ECLIPSE CALCULATION

Rtag longs and *rtsis 'phro* / *stong chen 'das lo* are major determinants of different astronomical traditions. These have been regarded among *Phug pa* scholars as the primary cause for the disagreement between *rtsis* and eclipse phenomena. Therefore, "saving the phenomena" has been tried by figuring out a possible correct / accurate longitude calculated from the considerations of *nur ster*, *rtsis 'phro* / *stong chen 'das lo* in an

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[631] Compare the values given in Kaḥ thog Rig 'dzin (1976-1977a) [= Kaḥ thog Rig 'dzin (2006a)]. The epoch is the same. See above pp. 210-3.

arithmetic way. The process goes together with observations and empirical data/ values of real eclipses verified by direct perception.

Moreover, it should be stressed that all the efforts for accuracy of eclipse calcuation are based upon the fundamenal religious meaning of eclipse in chapter 1, *bstan rtsis*. In other words, tallying *rtsis 'phro* / *stong chen 'das lo* of each system with the lunar eclipse at the Buddha's enlightenment was pivotal and crucial in the *Phug* traditions. Mi pham says,

> *... grub rtsis kyi rtsis 'phro btsal ba'i rtsis gzhung rnams la / sngon ston pa sangs rgyas pa'i dus kyi gza' 'dzin sogs dang bsgrigs shing / stong chen gyi lo tshogs sogs skar rtsis kyi gnad rnams mthar chags su dpyad pa zhib mos gtan la phab pas phug pa'i lugs nyid grags che la / phug pa'i rtsis gzhung lag len du bstar ba'i gzhung tshang la dpyis phyin par bshad pa smin gling lo chen pa'i rtsis gzhung nyin byed snang ba 'di legs bshad che bar mngon / 'di dang rtsis 'phro ster rgyu cung zad mi 'dra ba'i khyad par las / mtshur rtsis zhes grags pa dang / phyis su sum pa ye shes dpal 'byor gyis rtsis 'phro btsal ba dga' ldan rtsis gsar du grags pa dang / tho kwan gyi rtsis gzhung sogs rtsis 'phro'i dbang gis cung zad mi 'dra ba'i rtsis gzhung du ma gsar du byung / rnga ban kun dga'i mtshan can gyis rtsis gsar thub bstan mdzes rgyan zhes pa gza' 'dzin thig par de dus grags che yang gzhung nor tshabs che ba can du mthong / gzhan rnams rtsis 'phro'i dbang gis cung zad mi 'dra bar gyur cing / so so'i lugs kyi stong 'jug dang 'grigs pa dang / gza' 'dzin thig pa sogs rang bstod can de dag rtsa rgyud dngos las gsungs pa'i rtsis 'phro rnam dag rnyed pa yin min nges dka' yang re zhig de ltar byas pa la 'gal ba med do /*[632]
>
> ... By a decision according to the detailed investigation of the agreement with the [lunar] eclipse which occurred when the Buddha previously attained enlightenment and of the crucial points such as the *stong chen lo tshogs*, etc, one after another among the astronomical texts which sought the *rtsis 'phro* of the *grub rtsis*, it is manifest that Smin grol gling Lo chen Dharmaśrī's *Rtsis gzhung nyin byed snang ba*, which explains completely all the texts that put *Phug pa*'s astronomical texts into practice, is a supreme exposition among the texts known as the *Phug* system. From the qualities that the *rtsis 'phro*-s that should be added are a little different from this (= *Rtsis gzhung nyin byed snang ba*) newly

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[632] Mi pham (2012: 1027-8). Since he wrote Mi pham (2012a) not long after writing Mi pham (2012), the overlap of contents between the two are seen. For the account for *Rnga ban kun dga'i mtshan can gyi rtsis gsar* in Mi pham (2012a), see Mi pham (2012a: 249-58). The year when Mi pham (2012a) was written is uncertain. However, it looks to have been written in the last phase of his life. He died in 1912. The colophon in Mi pham (2012a) says: "[this text was written by] astronomer 'Jam dpal dgyes pa (= Mi pham), the one who summarized the eclipse of the ninth month (T. *dbyug zla = tha skar zla ba*) in the water-mouse year (= 1912) of the 15th *rab byung* (i.e. 1912/9/15), wrote. Be virtuous!". (*rab tshes chu byi dbyug zla'i nya yi gza' 'dzin mdor bsdus pa rtsis rig smra ba 'jam dpal dgyes pas bris pa dge /*).

> arose many astronomical texts which are a little different in terms of *rtsis 'phro* such as the one known as *Mtshur rtsis,* the one known as the *Dga' ldan rtsis gsar* whose *rtsis 'phro* was calculated by Sum pa Mkhan po later, Thu'u bkwan III's astronomical text, etc. The one called *Rtsis gsar thub bstan mdzes rgyan* [written] by a monk named Rnga ban Kun dga' was famous for the accuracy of eclipse at that time, but it is seen as a text with serious fallacy. [In the case of] the other texts [except for the *Rtsis gsar thub bstan mdzes rgyan*], they became a little different by *rtsis 'phro*, agree with the *stong 'jug* of the individual tradition, and self-praises such as the accuracy of eclipse, etc. are difficult to ascertain whether or not they are the correct *rtsis 'phro*s (*rtsis 'phro rnam dag*) which have been stated in the *Mūlatantra*, but there is no contradition in doing so for a while.

The meaning and significance of the eclipse is not only a system tester (barometer of the accuracy of an astronomical system), together with solstice measurement. Importantly, it is also is related to the essential and core parts of the entire astronomical system (especially in the *Phug* system), i.e. *rtsis 'phro* and *stong chen* calculation. More fundamentally, the accuracy of eclipse calculation is buttressed by the religious concept *bstan rtsis* (the calculation of the lunar eclipse at the Buddha's enlightenment). Under the larger rubric of *stong chen* combined with *rtsis 'phro*, the Buddha's enlightenment should be explained properly and correctly calculated according to each *Phug* system. That is also the meaning of *rtsis 'phro* / *stong chen 'das lo*.

However, *nur ster*, *rtsis 'phro* / *stong chen 'das lo* corrections based upon arithmetic were not good solutions in the sense that inaccuracy was inevitable. Whatever observational, empirical corrections, scholarly exchanges of information were adopted, they may not work, especially for a solar eclipse. In the same vein, in spite of the efforts made by his predecessors, Mi pham was not content with the eclipse predictions made by previous *Phug* systems based upon *rtsis 'phro* / *stong chen 'das lo* change.

... phug mtshur dgon lung pa sogs kyi rang 'dod kyi rtsis gzhi 'di rnams phal cher mig skar dang gza' 'dzin sogs 'grig dka' ba dang / stong 'jug gi ri mo sogs rgyud kyi dag pa dang mi 'grig pa la sogs pas na / dpal ldan rtsa ba'i rgyud kyi dngos bstan bsdus rgyud dbu zhabs kyi don thams cad dang mi 'gal ba / dus tshigs dang gza' skar dang lnga sgra gcan pa'i 'gros mngon sum bsnyon du med pa zhig yod na de la yi rang lan brgyar 'bul zhing de'i rjes su 'brang bar rigs pas so /[633]

... Since these *rtsis gzhi*-s[634] that *Phug* system, *Mtshur* system, *Dgon lung pa* (= Sum pa Mkhan po's *Dga' ldan rtsis gsar*),[635] etc. claim are mostly difficult to [show] the correspondence between the eclipse calculations, etc. and observation, and the values of *stong 'jug*, etc. do not agree with the accuracy of the *Kālacakratantra*, if there is a system which is not contradictory to all the meanings of the entire *Laghukālacakra*, i.e. actual teaching of the glorious *Mūlatantra*, which is an irrefutable system [by] direct perception in terms of the movement of season, *gza' skar*, (*gza'*) *lnga*, Sgra gcan, [I] will offer rejoice hundred times and should follow it.

He stated the status quo of eclipse calculations in the early 20th century and was critical of the existing systems. In all the *Phug*, *Mtshur*, *Dga' ldan rtsis gsar* systems, no correpondence between *rtsis* and phenomena (eclipses) exists. Of course, it is certain that he did not go beyond the boundary of the *Kālacakra* like all other Tibetan astronomers. He presents the following reasons for inaccuracy in eclipse calculation:

... gling 'dir mtho dman gyi mthong tshul zhig gi khyad yin pa 'dra zhing / der ma zad 'dzin dus kyi dbang gis gling 'di'i steng thad dang shar nub tu mthong ba'i khyad par dang / de dang bstun par yul dus bsgrig (sic. read *'grig) pa'i zhib cha sogs du ma zhig dgos par mngon no / khyad par du nyi 'dzin thig dka' bar snang / spyir ri mos ma thig pa min yang / dus ltas las ri mo bzhin du mi 'dzin pa dang / ri mo ma shar kyang 'dzin pa yod par gsungs pa dang / gza' 'dzin gyi dus gcig la yang bod yul pa so sos la las phyed 'dzin / la las ril 'dzin sogs su mthong ba sogs dngos su byung ba'i lo rgyus snang bas skabs la lar ri mor shar ba bzhin gza' 'dzin ma thig pa tsam gyis rtsis 'phro ma*

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[633] Mi pham (2012b: 351-2).

[634] The *rtsis gzhi* literally means the foundation of calculation. It can be regarded as *rtsis 'phro*, because *rtsis 'phro* is basic and foundational in *skar rtsis* calculations, being related to such values as *gza' dhru*, *nyi dhru*, *lnga bsdus*, etc..

[635] The *dgon lung pa* is Sum pa Mkhan po. For a brief introduction to Sum pa Mkhan po's life, see Yang (1969: 3-5, especially 5): "In 1746, he was appointed as abbot of Dgon lung."

> *dag pa'i nges pa mi snang la / rnam par kun tu ri 'mor shar ba bzhin thig pa'i rtsis gzhung bod na dkon par snang ngo.... /*[636]
>
> ... it seems that here in Tibet, there is peculiarity of way of being seen [by] high and low, and in addition to that, there is peculiarity that [an eclipse] is seen above / in front of this land and in the east and west [respectively] according to the timing of eclipse, and it is manifest that in accordance with it, manifold detailed analyses that [make timing] agree with regional time are necessary. Especially, a solar eclipse is difficult to be accurate. Although in general, the calculated values are not inaccurate, the timing (T. *dus*), sign (T. *ltas*), and karmic action (T. *las*)[637] are not grasped accoring to the values, and it was stated that although the values did not appear, there was an eclipse. And at the time of an eclipse, there are stories of real happenings that some local Tibetans observed a half-eclipse and some observed a total eclipse. So, on some occasions, the certainty of inaccurate *rtsis 'phro* does not exist by the inaccurary of an eclipse according to the value which predicts an eclipse[638], and an astronomical text that is accurate in all cases according to the value which predicts an eclipse is rare in Tibet.

Two key concepts and methods can be extracted: 1) geographical concerns, 2) *Mā yang rgya rtsis*. Firstly, he mentions that in the case of solar eclipse, there is no guarantee that the *rtsis 'phro* / *stong chen 'das lo* corrections are incorrect because there are possibilities that some other factors like geographical features are involved. He holds the view that attempts to increase the accuracy of eclipse calculations by *rtsis 'phro* / *stong chen 'das lo* correction may be an incorrect approach when the same eclipse appears differently according to different regions. Therefore, he stresses the considerations for geographical

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[636] Mi pham (2012: 1030).

[637] Tibetan eclipse calculation generally tackles 10 components: See Ku sri skyabs (1979: 36b-43a): 1. eclipse condition / possibility (T. *'dzin tshul*), 2. time (T. *dus tshod*), 3. direction (T. *'dzin phyogs*), 4. size (T. *cha yi che chung*), 5. duration of obscuration (T. *sgrib yun*), 6. part / direction in which an eclipse begins (T. *lus pa'i phyogs*), 7. color (T. *kha dog*), 8. part / direction in which an eclipse ends (T. *gtong ba'i phyogs*), 9. multiplication of virtue (T. *dge ba'i 'gyur khyad*). 10. fruition (T. *'bras bu*). Ku sri skyabs (1979: 40b-43a) spares many pages for the relgious concern, 9 and 10, which shows the meaning of eclipses in the Tibetan society.

[638] This means that there is no guarantee that the incorrect *rtsis 'phro* is the only reason why eclipse calculation is incorrect.

and regional features. As a matter of fact, these kinds of statements are found *passim* in Tibetan *rtsis* literature, especially in the case of the calculations of the solar eclipse, which also evidences that Tibetans have continuously made observations. As an example, Dkon mchog ’phrin las bzang po’s (1656-1718) (or his predecessors’) empirical knowledge about solar eclipse is as follows:

> *de yang ri la nye ring dang / ri yang shar nub mtho dma’ dang / ri klungs sa khyad yangs dogs* (*sic.* read *dog*) *dang / lung pa’i shar nub lho byang dang / lho byang nyi zla’i bgrod mtha’ dang / skabs de’i nyi zla ’char nub pa / legs par brtags pa gnad du che /*[639]
>
> Furthermore, it is important to investigate [following] the crucial points well: closeness to mountain, east, west, high and low of mountain, wide and narrow of moutain and valley and different geographical features, north, east, south, and west of region, movement of the sun and moon to the far end of south and north,[640] rise and set of the sun and moon on that occasion.

The geographical / local features are considered. The same kind of geographical concern for solar eclipse calculation is found in the 18th century Bstan ’dzin dpal ’byor. His considerations for a solar eclipse at 1776/10/30 –it did not occur– include *nur ster* (empirical data), height of mountain, the position of the sun in the summer and winter (T. *dbyar dgun gyi nyi ma*), territorial features (*sa khyad*), Chinese calculations (*thang brtsi* (*sic.*)), etc.[641] Also, Ku sri skyabs (1979), which is based upon the Sde srid, mentions the following geographical concern.

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[639] Dkon mchog ’phrin las bzang po (1975: 53b).

[640] For *lho bgrod* and *byang bgrod*, see Bsam ’grub rgya mtsho (2011: 117). See also note 428.

[641] For this quotation, see above p. 98.

lung ston bya ba'i yul de yi / shar nub ri bo'i mtho dma' dang / ri dang sa khyad nye 'gyangs dang / nya yi 'od dkar bdag po[642] *dang / nam mkha'i nor bu*[643] *'char nub dus / nyin mtshan chu tshod tsam sleb sogs / zhib tu brtags nas ma smras na / mkhas rlom byed pa'i rtsis mkhan 'ga' / 'dzin tshul kha dmar*[644] *log pa mang /*[645]

If [ ] do not speak after examining in detail east, west, moutain height, mountain and geographical features, distance, and the moon of the full moon day, the time of sun rise and sun set, the elapse of the *chu tshod* of day and night, etc. of the region that will be predicted, there are many cases in which some astronomers who pretend to know [how to predict an eclipse] make incorrect predictions.

Similar accounts on the geographical differences are reiterated in Tibetan *skar rtsis* texts but all of them are mere intuitive descriptions of the territorial features. Mi pham's above statement is basically an extension of the long-lasted intuition and belief that they influence the eclipse calculation results.

Secondly, in conjunction with Tibetan geographical concerns, Mi pham may imply the *Mā yang rgya rtsis* in the last line of the above passage (see above page 287), which is a contrast to the mere Tibetan geographical intuitive descriptions.[646] From a modern

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[642] For the synonyms of *zla ba* (M. *sumiy-a* < S. *saumya*), *'od dkar* (M. *čaγan gerel-tü*), *mtshan mo'i bdag po* (*söni-yin eǰen*), *snar ma'i bdag po* (*ruwagini* (*sic.* < S. *rohiṇī*)*-yin eǰen*, – It also appears as *rügini* even in the same text. There is no consistency in some Mongolian romanizations of Sanskrit words in Lcang skya III et al. (1982), Lcang skya III et al. (2002)) – *kha ba'i 'od* (*časun-u gerel-tü*), *rta dkar* (*čaγan mori-tu*), etc. are seen in Lcang skya III et al. (1982: 54-5), Lcang skya III et al. (2002: 1189-91).

[643] See Lcang skya III et al. (1982: 53) and Lcang skya III et al. (2002: 1185): *nam mkha'i nor* (M. *oγtarγui-yin čindamuni*).

[644] For this term, see *Bod rgya tshig mdzod chen mo* (2000: 205).

[645] Ku sri skyabs (1979: 36a).

[646] Since he knows the existence of *rgya rtsis* (more precisely *Mā yang rgya rtsis*), his statement may allude to it. Actually, the *Mā yang rgya rtsis* is mentioned in Mi pham (2012a: 1030-1), Mi pham (2012: *passim*). For Mi pham (2012), see Henning (2007: 99).

perspective, such factors as parallax, refraction, semi-diameter, etc should be incorporated for an accurate eclipse calculation. The *Rgya rtsis chen mo* from the *Xiyang xinfa lishu* and the *Mā yang rgya rtsis* from the *Lixiang kaocheng*, which will be briefly mentioned in the following section, are equipped with geometrical methods based upon trigonometry for the calculation of such crucial components.[647]

The following section has a two-fold aims: 1) to show fundamentally different methods, approaches, and bases for solar eclipse calculation in the two *rgya rtsis* astronomies translated into Tibetan, i.e. the *Rgya rtsis chen mo* and the *Mā yang rgya rtsis*, 2) to show how the heterogenious traditions have been received, understood, assimilated by the *skar rtsis* astronomy of Indic *Kālacakra* origin. The second purpose is a continuation of 2.4-2.5. in chapter 3 for logical consistency: the different "series" converge towards the *Kālacakra* on Tibetan soil.

[647] Research into the theory in the two Chinese texts/ systems, the *Xiyang xinfa lishu* and the *Lixiang kaocheng*, is beyond my scope. A series of difficult research is expected, and is being made by Chinese scholars. So, I just briefly mention the mathematical aspects related to understanding the Tibetan texts, the *Rgya rtsis chen mo* and the *Mā yang rgya rtsis* with a focus on the significance of them in the history of Tibetan astronomy.

2. *RGYA RTSIS*

2.1. GEOMETRIC AND TRIGONOMETRIC METHODS FOR THE CALCULATION OF A SOLAR ECLIPSE

2.1.1. A SKETCH OF THE METHODS DESCRIBED IN THE *TNGRI-YIN UDQ-A*

The *Xiyang xinfa lishu*, which is the original text of the *Tngri-yin udq-a* / *Rgya rtsis chen mo*, incorporates several unprecedented factors into an eclipse theory for accurate prediction, being based upon Tychonic astronomy.[648] As such, the translations, the *Tngri-yin udq-a / Rgya rtsis chen mo* have the factors, whether they were understood or not.

[648] For example, on the basis of the memorial addressed by Li Zhizao (李之藻 1565-1630) to the emperor Wanli (萬曆) in 1613 in which the publication of a calendar on the basis of western astronomical knowledge was requested, Chinese historian Gu Yingtai (1620-1690) summarizes some geographical knowledge where Western methods were superior to Chinese approaches. In it, some components incorporated into an eclipse calculation are as follows: Gu (1977: 1224-5): 一 ... 地經各有測法，從地窺天，其自地心測算，與自地面測算者，都有不同。... 九曰太陰小輪，不但算得遲疾，又且測得高下遠近大小之異，... 十曰日月交食，隨其出地高低之度，看法不同。...十一曰日月交食，... 凡地面差三十度，則時差八刻二十分。 十二曰日食與合朔不同。日食在午前，則先食後合；在午後，則先合後食。... 十三曰日月食所在之宮，每次不同 ... . The translation with my explanation is as follows: "1) ... there is an individual method for measurement of the diameter of the earth: being measured and calculated from the center of the earth is different from that from the surface of the earth, in observing the sky from the Earth. — This explains the diurnal parallax (Ch. *dibanjingcha*) — ... 9) The epicycle (Ch. *xiaolun* 小輪) of the moon is calculated not only by slackening / hastening difference (Ch. *chijicha* 遲疾差), but also by the difference of high and low, distance, and size. ... 10) As for lunar and solar eclipse, the way of its being seen is different according to the latitude (Ch. *beiji chudi* (北極出地) or *beiji gaodu* (北極高度) = the angle between surface of the earth and light from polaris. This is similar to present-day latitude). 11) As for lunar and solar eclipses, ... in general, a 30° difference of the surface of the earth (i.e. the difference of longitude) equals the time difference (Ch. *shicha* 時差) 8 *ke* (刻) 20 *fen* (分) (= 120 modern minutes = 2 modern hours = 30°. 1 *ke* = 14.4 modern minutes and 10 *fen* = 2.4 modern minutes according to traditional Chinese calendrical units before the *Shixianli* was used. For these units, see below note 750). 12) [the timing of] a solar eclipse is not identical with the conjunction (Ch. *heshuo* 合朔). When a solar eclipse occurs in the morning, the eclipse first occurs and then conjunction (合) occurs; when [a solar eclipse occurs] in the afternoon, a conjunction

It is impossible to show the entire contents of the *Tngri-yin udq-a* / *Rgya rtsis chen mo*. Simply, the original text *Xiyang xinfa lishu* is a technically difficult text. I briefly introduce the concept of the parallax (Ch. *shicha* 視差. M. *qaraqu dutaγu* / T. *blta ba'i dman pa*) included in the *Jiaoshibiao* (交食表 Tables for Eclipse Calculation) in the *Xiyang xinfa lishu*, which is the central concept for eclipse calculation. In fact, as the *Jiaoshibiao*, the title of the chapter, indicates, it is filled with the tables which were created on the basis of a trigonometric method, except for some explanations. It attests to the fact that the *Tngri-yin udq-a* / *Rgya rtsis chen mo* were translated for practical purpose, not for theoretical purpose.[649] In the *Jiaoshibiao* / *solbičan bariqu-yin bodurul* / *bsnol bar 'dzin pa'i ngos 'dzin,* the nonagesimal point is used to calculate parallax necessary for such cases as the eclipse possibility, apparent longitude of the sun and moon, time of apparent mid-eclipse, etc.

> 表右直行從二十七起至八十九止分三段為地平高度 地平高度即距天頂之餘 上橫行從一至八十九為太陽距黃平象限之度 算日食必以黃平象限表求太陽距本限若干 [650]

occurs first and then the eclipse occurs. — This is related to the use of the nonagesimal later in Qing China. In fact, the calculation is made with respect to the nonagesimal (Ch. *huangpingxiangxian* 黃平象限 / *baipingxiangxian* 白平象限), not the meridian (Ch. *ziwuxian* 子午線) as stated here. — 13) the zodiac (Ch. *gong* 宮) in which eclipse occurs is different every time." Among them, 1), 9), 12) are closely tied to parallax. 10), 11) reflect knowlege of a coordinate system, latitude and longitude. They were two main factors that Qing Chinese astronomers thought were pivotal for accurate eclipse calculation results.

649 For a relevant explanation, see above pp. 161-4.

650 Rho et al (2000: vol. 2, 185) [= Rho et al. (1983: *SKQS*, vol. 789: 440)].

> *bodurul-un, ǰegün sidurγu šuγum-dur, qorin doluγan-ača ekileǰü, nayan yisün-dür kürtel-e, γurban anggi qubiyaǰu γaǰar-un tübsin-ü öndür qonuγ bolγaǰuqui.* *γaǰar-un tübsin-ü öndür qonuγ anu, mün tngri-yin orui-ača böglegüü-yin ulegüü.* *Degedü kündelen šuγum-dur, nigen-eče nayan yisün kürtel-e, naran, sir-a tübsin baidal-un quγuča-ača böglegüü-yin qonuγ bolγaǰuqui, naran-i bariqui-yi boduqui-dur, erke ügei sir-a tübsin baidal-un quγuča-yin bodurul-i kereglеǰü, naran, über-ün quγuča-ača böglegüü-yin kedüi-yi erimüi.*[651]

The Tibetan translation of the above Mongolian passage is as follows:

> *ngos 'dzin gyi g.yon gyi thig drang po la / nyer bdun nas 'go byas te gya dgur slebs pa'i bar du / dum bu gsum du bgos te / sa'i snyoms pa'i zhag mthon por byas so / sa'i snyoms kyi zhag mthon po ni / gnam nyid kyi gtsug nas rgyang ba'i lhag pa / steng gi 'phred thig la / gcig nas gya dgu'i bar du / nyi ma ser po snyoms babs kyi thun las rgyang ba'i zhag tu byas so / nyi ma 'dzin pa dpyad pa la / dbang med par ser po snyoms babs kyi thun kyi ngos 'dzin dgos te / nyi rang gi thun las rgyang ba'i ji tsam btsal ba'o /*[652]

A possible Tibetan reading would be like this.

> Dividing the vertical line of the right in the recognition into three portions beginning from 27 until reaching 89, [ ] take [them] as high degree of the earth's level (T. *sa'i snyoms pa'i zhag mthon po.* This is a literal translation of M. *γaǰar-un tübsin-ü öndür qonuγ* < Ch. *diping gaodu* 地平高度. altitude). The high degree of earth's level is the remainder of the distance from the zenith. [ ] take the upper horizontal line as the degree of the sun distant from the session of yellow even descending (T. *nyi ma ser po snyoms babs kyi thun las rgyang ba'i zhag* < M. *naran, sir-a tübsin baidal-un quγuča-ača böglegüü-yin qonuγ* < Ch. *taiyang ju huangpingxiangxian zhi du* 太陽距黃平象限之度) from 1 to 99. In investigating a solar eclipse, [ ] inevitably needs the recognition of the session of yellow even descending (T. *ser po snyoms babs kyi thun kyi ngos 'dzin*), finds the amount distant from the session of the sun (T. *nyi rang gi thun las rgyang ba* < M. *naran, über-ün quγuča-ača böglegüü* < Ch. *taiyang ju benxian* 太陽距本限).

The Tibetan terminology used is not understandable. It is mostly literal rendering from Mongolian done without an understanding of the concepts. No Tibetanization of the concepts and terms are seen. The point in this example is that no Tibetan would

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[651] Čeden et al. (1990: 647).

[652] *Rgya rtsis chen mo* (1715/1716: 2a).

understand the Tibetan without an understanding of modern astronomy in Chinese. Even with such knowledge, this kind of Tibetan renderings is awkward. The above passage means the following:

> The first column from the right in the table, [in which] 27 to 89 [are written and which is] divided into the three [27~47, 48~68, 69~89], is altitude. The altitude is the remainder of the distance from the zenith. The uppermost row [in which] 1 to 89 [is written] is the degree of the sun's distance to the nonagesimal. In the calculation of solar eclipse, it is necessary to find the sun's distance to the relevant quadrant (Ch. *taiyang ju benxian* 太陽距本限) by looking up in the table of the nonagesimal.

Parallax in solar eclipse is determined by the altitude of the nonagesimal and the distance of the sun from it.[653] It is not likely that Tibetans knew this basic, but crucial geographical knowledge from the West thru China.

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[653] Parallax increases the apparent zenith distance of a celestial object. In the case of solar eclipse, it significantly influences the instant of opposition, duration, magnitude, etc. In the *Xiyang xinfa lishu*, the nonagesimal point (also called the mid-heaven (L. *medium coeli*). Ch. *huangpingxiangxian* 黄平象限) is computed for parallax. To give an explanation of the point, it is the highest point of the ecliptic above the horizon, and its altitude is reckoned from the rising point, i.e. intersection of the ecliptic with the horizon. The reason why it is used to calculate parallax is that when a celestial object is on the nonagesimal point, only its latitude is affected (= there is no longitudinal parallax on that point. The parallax on the point is entirely latitudinal. Therefore, the increase and decrease of the longitude can be determined with this point as a division point.). Neugebauer (1962: 71) holds that the term nonagesimal was coined by Kepler. Parallax calculation in the case of Kepler is explained well in Kepler. tr. Donahue (1992: translator's introduction 12-5, 237, n. 10). The formular is given in Kepler. tr. Donahue (1992: 238, n.13): "The longitudinal parallax $= P \sin A \sin d$, where P is the total parallax at the horizon; A is the altitude of the nonagesimal; d is the distance of the planet from the nonagesimal." Also see Smart, revised by Green (1977: 204-6). Since Kepler, the method using the nonagesimal point became wide-spread in 17-8th century Europe. Many technical books on ocean navigation published at that time introduce the method. For example, peruse the judgement of eclipse in Samuel Vince (1749-1821) (1810: 173)!: "To the latitude of the given place, and the horizontal parallax of the moon from the sun at the time of the ecliptic conjunction, compute the moon's parallax in latitude and longitude from the sun; the parallax in latitude applied to the true latitude gives the apparent latitude of the moon from the sun; and the parallax in longitude shows the apparent difference of the longitudes of the sun and moon. ... If the moon be to the east of the nonagesimal degree, the parallax increases the longitude; if to the west, it diminishes it. ... find the sun's and the moon's true longitude, and the moon's true latitude, from their horary motions; and to the same time compute the moon's parallax in latitude and longitude from the sun; apply the parallax in latitude to the true latitude, and it gives the apparent latitude of the moon from the sun; take the difference of the sun's and moon's true longitude, and apply the parallax in longitude, and it gives the apparent distance of the moon from the sun in longitude." This algorithm is totally understandable and familiar to contemporary Qing China

My explanation of the parallax calculation in the *Tngri-yin udq-a / Rgya rtsis chen mo* stops here. There are several reasons. Firstly, the theory and mathematics in the *Rgya rtsis chen mo* were never understood in Tibet. In fact, there is no evidence that the text was freely circulated. In fact, the *Rgya rtsis chen mo* had no significance in Tibetan intellectual history. The general mathematical method for the parallax calculation by

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astronomers who studied the *Xiyang xinfa lishu* and the *Lixiang kaocheng* / *Lixiang kaocheng houbian* of Jesuit origin — It also means that the algorithm was introduced in the *Tngri-yin udq-a* / *Rgya rtsis chen mo* and the *Mā yang rgya rtsis* from the *Xiyang xinfa lishu* and the *Lixiang kaocheng* respectively. — Especially about the method using the nonagesimal, it clearly states that when a celestial body is to the east of the nonagesimal, the parallax increases the longitude; and when it is to the west, it diminishes the longitude. — This instruction is also seen in the *Tngri-yin udq-a* / *Rgya rtsis chen mo* and the *Mā yang rgya rtsis*. — At this point, I think that it is highly possible that the jesuits, who came to Qing China with considerable knowledge of astronomy and navigation, were familiar with the method based upon trigonometry and disseminated the knowledge by means of writing astronomical books and teaching it in Qing court. If we move the topic to the context of Indian astronomy, it is verified that intriguingly, calculating parallax from the nonagesimal (S. *vitribha*) in the case of solar eclipse has been a typical way of computing parallax in India from ancient time. Let me introduce a little bit because it helps to understand the nonagesimal method in the *Rgya rtsis chen mo* and the *Mā yang rgya rtsis*. In the same manner with the previous European method, in the Indian tradition, the astronomers have broadly divided the effect of parallax in two parts, namely the parallax in longitude (S. *lambana*) and the parallax in latitude (S. *nati*). See Montelle and Plofker (2014: 8): "Longitudinal parallax (*lambana*) along the ecliptic is determined chiefly by the distance of the body from the nonagesimal, a point on the ecliptic 90° west of the ascendant or intersection point of the ecliptic with the eastern horizon. Latitudinal parallax (*nati*) perpendicular to the ecliptic is based on the zenith distance of the nonagesimal, hence dependent on the situation of the ecliptic with respect to the local zenith." This is basically the same with the aforementioned European method. Since the Indian method is not my topic, I restrict myself to introducing some research into primary sources. For a understanding by the example of actual calculation, see Brahmagupta's *Khaṇḍakhādyaka*. tr. Sengupta (1934: 104-14) with a mathematical explanation (1934: especially, 99-100) and Sengupta (1918: 1-18). Additionally, there are hundreds of excellent research into the method of the nonagesimal in Indian ancient astronomy. For example, see the translation of the *Sūryasiddhānta* by Burgess (1977 [c. 1860]: introduction 37-40, 161-77), research into Varāhamihira's *Pañcasiddhāntikā* by Thibaut and Sudhākaradvivedī (2002 [c. 1889]: 71-4), the updated research into the *Pañcasiddhāntikā* with corrections of the errors of Thibaut and Sudhākaradvivedī by Neugebauer and Pingree (1970-1971: Part 1: 82-99; Part 2: 56-77), Pingree (1978), research into Āryabhaṭa's (476-550) Āryabhaṭīya by Yano (1980: 71-2), a nice research into Brahmagupta's *Brāhmasphuṭasiddhānta* by Yano (1982: 391-406). Tang2 and Qu (2005: 56-62), Tang2 and Qu (2005a: 197-213), an excellent research by Montelle (2011: *passim*), Tang2 (2011), research into Nīlakaṇṭha Somayājī's (1443-1545) *Tantrasaṅgraha* by Ramasubramanian and Sriram (2011: introduction xliii-xliv, 305-20), an excellent research into Jñānarāja's (16th c.) *Siddhāntasundara* by Knudsen (2014: 267-92), Shah (2015), etc.. Intriguingly, in the *Jiuzhili* (九執曆 c. 718), the Indian calendar in Tang China, written by Jutanxida (瞿曇悉達 < S. Gautama siddha), latitudinal parallax of the moon was reflected together with the semi-diameter, meanwhile longitudinal parallax was not applied. For the information, see Yabuuchi (1979: 47-8).

using the *Mā yang rgya rtsis* is explained below. The mathematics is the same and the method using the nonagesimal is also the same in the *Mā yang rgya rtsis*, not because it derives from the *Rgya rtsis chen mo*, but because it is from the *Lixiang kaocheng*.

2.1.2. A SURVEY OF THE METHODS DESCRIBED IN THE *MĀ YANG RGYA RTSIS*

The *Mā yang rgya rtsis* is a Tibetan version of the algorithm of eclipse calculation in the *Lixiang kaocheng*.[654] It incoporates elements such as parallax, semi-diameter, etc.

[654] To give a sense of the algorithm, I pinpoint the corresponding parts between the two texts. [ ] below is Huang and Chen’s (1987a) numbering adopted by me for convenience sake.

	Lixiang kaocheng (*SKQS*, Vol. 790) = He et al. (1985: 649b~699a).		Huang and Chen (1987a) *Rgya rtsis snying bsdus*	
	Lunar eclipse	Solar eclipse	Lunar eclipse	Solar eclipse
Step 1	mean motion at mean full moon day (Ch. *pingwang zhu pingxing* 平望 諸平行).	mean motion at mean new moon day (*pingshuo zhu pingxing* 平朔 諸平行	*rtsa ba’i dhru wa lnga* (monthly value): [11]~[15].	
	(650a~650b)	(677a~677b)	[21]~[25]: full moon day value.	[16]~[20]: new moon day value.
Step 2	the difference between the sun and moon (*riyue xiangju* 日月相距)		[26]~[28]	[26]~[28]
	(650b~651b)	(677b~678a)		
Step 3	true argument (*shiyin* 實引)		*nges pa’i rang ’gros*	
	(651b)	(678a~678b)	[29]~[30]	[29]~[30]
Step 4	true full moon (*shiwang* 實望)	true new moon (*shishuo* 實朔).	*nges pa’i nya*	*nges pa’i tshes*
	(652a~652b)	(678b~679b)	[31]~[33], [35]	[31]~[34]
Step 5	*jiaozhou* (交周)		*rā gdong bar khyad*	
	(652b~653a)	(679b)	[37], [39]	[37], [39]
Step 6	true longitude of the sun (*taiyang shijing* 太陽實經)			
	(653a~653b)	(679b~680a)	[36], [38],[40]	[36], [38],[40]
Step 7	*shiwang yongshi* (實望用時)	*shishuo yongshi* (實朔用時)	*dag pa’i nya*	*dag pa’i tshes*
	(653b~654b)	(680b~681a)	[41]~[43]	[41]~[43]
Step 8	*shishen juwei* (食甚距緯) and mid-eclipse (*shishen* 食甚)	*shishen shiwei* (食甚實緯) and *shishenyongshi* (食甚用時)	*’dzin rdzogs bar khyad dag pa* and *’dzin rdzogs*	*’dzin rdzogs kyi mkho ba’i dus tshod*
	(654b~655b)	(681a~681b)	[51]~[55]	[52]~[55]

which are unprecedented in *skar rtsis*.[655] Steps 9, 10, 11, 12, 13 for the calculation of a solar eclipse according to the division of the steps in the *Lixiang kaocheng* (also in the *Mā*

n/a	Step 9. *shishen jinshi* (食甚近時)	n/a	*'dzin rdzogs kyi nye ba'i dus tshod*
	(681b~685a)		[101]~[112]
n/a	Step 10. true time of mid-eclipse (*shishen zhenshi* 食甚真時)	n/a	*'dzin rdzogs bden pa'i dus tshod*
	(685a~687b)		[113]~[121]
Step 9. magnititude (*shifen* 食分)	Step 11. magnititude (*shifen*)	*'dzin cha*	*'dzin cha*
(655b~656b)	(687b~690b)	[56]~[62]	[122]~[135]
Step 10. *Chukui fuyuan shike* (初虧復圓時刻. time of first and last contact): (656b~657a). Step 11. *Shiji shengguang shike* (食既生光時刻. time of second and third contact): (657a~657b)	Step 12. first contact (*chukui* 初虧).	[63]~[72]: *'dzin ma thag* (first contact [68]) *btang zin* (last contact [69]) *sgrib ma thag* (second contact [71]) *mtha' nas gso* (third contact [72])	*'dzin mgo*
	(690b~693b)		[136]~[163]
	Step 13. true time of last contact (*fuyuan zhenshi* 復圓真時).		*btang zin*
	(694a~699a)		[139]~[164]

*** [80]~[99] has not been given by Huang and Chen (1987a). It is not difficult to know the reason before reading the manuscript of the *Rgya rtsis snying bsdus*. In case that I do not find a Tibetan equivalent in the *Mā yang rgya rtsis*, I leave the relevant entry blank.

Step 1 is the computation of mean conjunctions. Step 2 to step 7 are the computation of true conjunctions. In them, step 5 is the calculation of the distance between Rāhu and the moon (T. *rā gdong bar khyad*: longitudinal distance between the moon and the node (*rā gdong*). With this distance as the argument, the latitude of the moon is calculated) for the judgement of the possibility of an eclipse. Step 6 is the computation of true longitude of the sun according to the Chinese equatorial coordinate system. — Traditionally in China, the equatorial coordinate has been used. It was not regarded as an important part in the *Mā yang rgya rtsis*, possibly because the Tibetan *Kālacakra*/ *skar rtsis* astronomy is based upon the ecliptic coordinate system.— Step 8 is the calculation of the timing of true mid-eclipse to which parallax corrections will be followed in the case of solar eclipse. — We do not need to calculate parallax effect in the case of lunar eclipse. — Step 9 to step 10 in the case of solar eclipse are the process of parallax corrections through which the timing of apparent mid-eclipse is approximated. Most of all, exploiting the three steps (step 8 to step 10), *yongshi* (用時. T. *mkho ba'i dus tshod / mkho dus*), *jinshi* (近時. T. *nye ba'i dus tshod / nye dus*), and *zhenshi* (真時. T. *bden pa'i dus tshod* / *bden dus*) is known as the method of the *Lixiang kaocheng*. For the explanation, see Zhang1 (2014: 166-9). — It means that the method of the *Mā yang rgya rtsis* is closely tied to that of the *Lixiang kaocheng*. — Step 11 to Step 13 in the case of solar eclipse are the computation of magnititude and timing of each contact, being based upon geographical / observational knowledge on the semi-diameter, distance between the moon and the earth, the semi-diameter of the earth's shadow, and parallax. Given the *Rgya rtsis snying bsdus*, the *Mā yang rgya rtsis* has several features: generally, it omitted detailed sub-steps in the Chinese algorithm. And its renderings are not based upon conceptual or theoretical understanding. Rather, it is focused on the process of calculations and did not take a good care in grasping the new Chinese astronomical concepts and theories. And it does not understand trigonometry which is one of the major mathematical bases in the *Lixiang kaocheng*. — see the following explanation for step 9. — Instead, it just uses the tables which have been created by trigonometrical calculations. — For the tables used in the *Mā yang rgya rtsis*, see above pp. 159-60. —

[655] No consideration on such factors as semi-diameter of the sun and moon, semi-diameter of the earth's shadow, parallax in *skar rtsis* eclipse calculations shows a sharp contrast with *Mā yang rgya rtsis*. However,

yang rgya rtsis) shows clearly that the mathematical basis for parallax calculation is trigonometry. The procedures for each step in the five steps are basically the same. So, step 9 is briefly described below. Note that many sub-steps are omitted and trigonometry is not explicit in the *Mā yang rgya rtsis*. It just uses the tables copied from the Chinese texts, the *Lixiang kaocheng* / the *Lixiang kaocheng houbian*. A comparison of the step 9 between the *Lixiang kaocheng* and the *Rgya rtsis snying bsdus* is as follows:[656]

Table 42.

Lixiang kaocheng[657] (1985: 681b-685a)	*Rgya rtsis snying bsdus* Huang and Chen (1987a: 367-9) ([101]-[112])

about parallax in *skar rtsis* calculations, Henning (2007: 126-7): "There is no component of the Tibetan calculations for eclipses that corrects for an observer's position on the Earth. However, the numbers used in attempting to predict eclipses are clearly based on observations in the northern hemisphere, ... the basic calculations are effectively relative to the center of the Earth."

656 The above step 9 dramatically shows that the *Mā yang rgya rtsis* omitted most of the complex and difficult sub-steps in the *Lixiang kaocheng*. While the latter covers detailed sub-steps for the target of the step, the former calculates *huangpingxiangxian juwudufen* (T. *mkho dus bgrod mnyam dkyil khyad dus tshod*) and *huangpingxiangxian gongdu* (T. *mkho dus bgrod mnyam dkyil gyi khyim zhag*) directly from the target of the previous step, i.e. *shishen yongshi* (T. *'dzin rdzogs kyi mkho ba'i dus tshod*). And on the basis of them, the *shishen jinshi* (T. *'dzin rdzogs kyi nye ba'i dus tshod*) is calculated. Simply, *'dzin rdzogs kyi nye ba'i dus tshod* = *'dzin rdzogs kyi mkho ba'i dus tshod* + *nye dus bar khyad* (= parallax corrections). — This omission is repeated in step 10: *'dzin rdzogs bden pa'i dus tshod* is calculated directly from *'dzin rdzogs kyi mkho ba'i dus tshod* (the target of this Step) with parallax corrections. In other words, *'dzin rdzogs bden pa'i dus tshod* = *'dzin rdzogs kyi mkho ba'i dus tshod* + *bden dus bar khyad*. — And this step omits the relevant calculations which are needed to compute the *dongxicha* (T. *shar nub dman cha.* For this term, see below note 669) from *xianjudigao* (T. *mkho dus dkyil sa'i bar khyad mtho zhag*). I think that this kind of tendency is partly because of the use of the tables and partly because of ignorance of trigonometry by the author of the *Rgya rtsis snying bsdus*.

657 I do not know how to render each technical vocabulary. As such, this is left for future study.

Table 42 (continued)

yongshi chunfen juwu chidaodu (用時春分距午赤道度)	n/a
yongshi chunqiufen juwu chidaodu (用時春秋分距午赤道度)	n/a
yongshi chunqiufen juwu huangdaodu (用時春秋分距午黃道度) [658]	n/a
yongshi zhengwu huangchi juwei (用時正午黃赤距緯)[659]	n/a

[658] See He et al. (1985: 682a) presents this proportional expression based upon trigonomtry:
cos(ε = 23°29'30"): semi-diameter 10000000 of *bentian* (本天, deferent) = tan(*yongshi chunqiufen juwu chidaodu*): tan(a) .

$a = 180/\mathrm{pi} \times \frac{\mathrm{atan}(10000000 \times \tan(\mathit{yongshi\ chunqiufen\ juwu\ chidaodu} \times \mathrm{pi}/180)}{\cos(23.491667 \times \mathrm{pi}/180))}$ = *yongshi chunqiufen juwu huangdaodu* .

The ε is *huangchi daju* (黃赤大距) / *huangchijiaojiao* (黃赤交角) in Chinese. The *Lixiang kaocheng* changed ε from 23°31'30'' (value in the *Xiyang xinfa lishu*) into 23°29'30'' (= 23.491667). For the information, see He et al. (1985: 3b) stating that it is a value of Tycho Brahe. See also Shi (1993: 460-1). — This kind of information is nowhere in the *Rgya rtsis snying bsdus*. It is nonsensical to say that the *Mā yang rgya rtsis* is based upon Tychonic astronomy. It is just the algorithm of eclipse calculation which derives from the *Lixiang kaocheng*. — For the motion of the sun in the *Lixiang kaocheng*, see Ōhashi (2007).

[659] He et al. (1985: 682b):
10000000 : sin(ε) = sin(*yongshi chunqiufen juwu huangdaodu*): sin(b).

$b = 180/\mathrm{pi} \times \mathrm{asin}(\frac{\sin(23.491667 \times \mathrm{pi}/180) \times \sin(\mathit{yongshi\ chunqiufen\ juwu\ huangdaodu} \times \mathrm{pi}/180)}{10000000})$ = *yongshi zhengwu huangchi juwei*.

Table 42 (continued)

yongshi huangdao yu ziwujuan jiaojiao (用時黃道與子午圈交角)[660]	n/a
yongshi zhengwu huangdao gongdu (用時正午黃道宮度)	n/a
yongshi zhengwu huangdaogao (用時正午黃道高) [661]	n/a

[660] He et al. (1985: 682b):
sin(*yongshi chunqiufen juwu huangdaodu*) : 10000000 = sin(*yongshi chunqiufen juwu chidaodu*) : sin(c)
$c = 180/\mathrm{pi} \times \mathrm{asin}(\frac{10000000 \times \sin(yongshi\ chunqiufen\ juwu\ chidaodu \times \mathrm{pi}/180}{\sin(yongshi\ chunqiufen\ juwu\ huangdaodu \times \mathrm{pi}/180})$ = *yongshi huangdao yu ziwujuan jiaojiao* .

[661] He et al. (1985: 682b-683a): In case that *yongshi zhengwu huangdao gongdu* is 3 to 8 *gong* (宫), *yongshi zhengwu huangdaogao* = *yongshi zhengwu huangchi juwei* + 50.083333 . In case that it is 9 to 2 *gong*, *yongshi zhengwu huangdaogao* = 50.083333 − *yongshi zhengwu huangchi juwei.* 50.083333 equals 50°05', the value of the equatorial altitude at Beijing (Ch. *jingshi chidaogao wushi du lingwu fen* 京師赤道高五十度零五分). In other words, the calculation of the *Lixiang kaocheng* / *Mā yang rgya rtsis* is based upon Beijing.

Table 42 (continued)

yongshi huangpingxiangxian juwudufen (用時黃平象限距午度分)[662]	*mkho dus bgrod mnyam dkyil khyad dus tshod* ([104])/ ([105]). Table: {*ma*} *bgrod mnyam bar khyad kyi re'u mig.*[663]
yongshi huangpingxiangxian gongdu (用時黃平象限宮度)	*mkho dus bgrod mnyam dkyil gyi khyim zhag* ([106]). Table {*ma*}: *bgrod mnyam bar khyad kyi re'u mig.*

[662] He et al. (1985: 683a):
cos(*yongshi huangdao yu ziwujuan jiaojiao*): 10000000 = tan(*yongshi zhengwu huangdaogao*): tan(d).
$d = 180/pi \times atan(\frac{1000000 \times tan(yongshi\ zhengwu\ huangdaogao \times pi/180)}{cos(yongshi\ huangdao\ yu\ ziwujuan\ jiaojiao \times pi/180)})$
$90 - d =$ *yongshi huangpingxiangxian juwudufen* .
For the calculation of a solar eclipse at a particular place, parallax in latitude and longitude of point of observation should be reflected. That is why the value of the *huangpingxiangxian juwudufen* is calculated. In this case, the value is based upon the latitude (φ) at Beijing, 39°55' (Ch. *beijichudi* 北极出地). — For this value, see He Mei et al. (1985: *passim*). —

[663] The *Bgrod mnyam bar khyad kyi re'u mig* (Table {*ma*}. Ch. *huangpingxiangxian biao* 黄平象限表) on which the *Mā yang rgya rtsis* is based for the calculation of the value of *mkho dus bgrod mnyam dkyil gyi khyim zhag* (Ch. *huangpingxiangxian juwudufen*) may have not worked properly since it was not created on the basis of the latitude of Tibetan areas. And it looks that Tibetan lamas who functioned in Beijing and witnessed the new method did not have information on the latitude and longitude in Tibetan areas. — It is a difficult issue. Manchu dynasty implemented nationwide measurements of latitude and longitude in the 18th century. Mongolian and Tibetan areas were also included. The topic is beyond my scope. It would suffice to conjure up the latitude information for Mongolian regions included in chapters 24-32 in *Tngri-yin udq-a.* See above note 356. — My argument is supported by my reading on later *Mā yang rgya rtsis* texts: there is no evidence that the *Mā yang rgya rtsis* authors had an accurate information on latitude / longitude in such regions as Lhasa, Amdo, Khams, etc., where they lived. Most of all, the word 'latitude' does not appear in the *Mā yang rgya rtsis* texts. — In them, the *dkyus zhag* is used for 'logitude.' — Of course, because the *skar rtsis* texts show a clear sense of different length of day and night according to different region, it may be assumed that Tibetan astronomers were aware of the parallel-/ quasi concept of φ. Research is need in both *skar rtsis* and *Mā yang rgya rtsis* traditions.

Table 42 (continued)

yongshi yuejuxian (用時月距限)[664]	*mkho dus zla dkyil bar khyad* ([107]).
yongshi xianju digao (用時限距地高)[665]	*mkho dus dkyil sa'i bar khyad mtho zhag* ([108]). Table {*ma*}:*bgrod mnyam bar khyad kyi re'u mig*
yongshitaiyingaohu (用時太陰高弧)	n/a
yongshi huangdao gaohu jiaojiao (用時黄道高弧交角)[666]	n/a

[664] He et al. (1985: 683b) / Huang and Chen (1987a: 368): *yuejuxiandu* (月距限度. T. *zla dkyil bar khyad*) = *huangpingxiangxian gongdu* (T. *bgrod mnyam dkyil gyi khyim zhag*) – *taiyang huangdao jingdu* (太陽黄道經度. T. *nyi ma'i nges zhag*).

[665] He et al. (1985: 683b):
10000000 : sin(*yongshi huangdao yu ziwujuan jiaojiao*) = cos(*yongshi zhengwu huangdaogao*) : cos(e).
$$e = 180/\mathrm{pi} \times \mathrm{acos}\left(\frac{\sin(yongshi\ huangdao\ yu\ ziwujuan\ jiaojiao \times \mathrm{pi}/180) \times \cos(yongshi\ zhengwu\ huangdaogao \times \mathrm{pi}/180)}{10000000}\right)$$
= *xianju digao* (限距地高; T. *dkyil sa'i mtho zhag.* altitude of the nonagesimal point)

[666] He et al. (1985: 683b-684a):
sin(*yuejuxian*) : cot(*yongshi xianju digao*) = 10000000 : tan (f)
$$f = 180/\mathrm{pi} \times \mathrm{atan}\left(\frac{\tan((90 - yongshi\ xianju\ digao) \times \mathrm{pi}/180) \times 10000000}{\sin(yuejuxian \times \mathrm{pi}/180)}\right) = huangdao\ gaohu\ jiaojiao\,.$$

Table 42 (continued)

yongshi baidu gaohu jiaojiao (用時白道高弧交角)[667]	
taiyangjudi (太陽距地)	
taiyinjudi (太陰距地)	
yongshi gaoxiacha (用時高下差)[668]	*zla sa'i bar khyad* ([101]). Table {*ba*} *zla sa'i phyed srid bar khyad kyi re'u mig*. *zla ba'i mtho dma'* ([102]). *zla ba'i mtho dma'i cha rags* ([103]). *mkho dus dus cha chen po* ([109]). Table {*tsha*}: *dus cha'am shar nub lho byang dman cha'i re'u mig.*

[667] He et al. (1985: 684a). The *Lixiang kaocheng* uses *baipingxiangxian* (白平象限), not *huangpingxiangxian* (黄平象限). For a theoretical explanation and justification of it, see He et al. (1985: 312-76): the *huangpingxiangxian* (= the nonagesimal in the Western sense) is measured from the ecliptic. Meanwhile, the *baipingxiangxian* (白平象限. the nonagesimal in the Chinese sense) is measured from the path of the moon. However, the difference was slight. For more information, see Tang (2011: 193-5), Zhang1 (2014: 177). It may be the reason why the *Mā yang rgya rtsis* is based upon the former method. Or, it may be due to the Tibetan tradition which is accustomed to using the ecliptic, not the lunar orbit. In contrast, traditional Chinese astronomy is accustomed to using the lunar orbit in calculating astronomical phenomena.

[668] He et al. (1985: 684b): *gaoxiacha* (Ch. 高下差. lit. high-low difference. > T. *mtho dma'i bar khyad*) = *taiyin dibanjingcha* (Ch. 太陰地半經差 = diurnal parallax of the moon. T. *zla sa'i phyed srid*) – *taiyang dibanjingcha taiyang dibanjingcha* (Ch. 太陽地半經差 = diurnal parallax of the sun). For an explanation in the *Mā yang rgya rtsis*, see Huang and Chen (1987a: 638).

Table 42 (continued)

yongshi dongxicha (用時東西差)[669]	*mkho dus shar nub dman cha* ([110]). Table {*tsha*}: *dus cha'am shar nub lho byang dman cha'i re'u mig.*
jinshi jufen (近時距分)	*nye dus bar khyad* ([111]).
shishenjinshi (食甚近時)	*'dzin rdzogs kyi nye ba'i dus tshod* ([112]).

The *Lixiang kaocheng* indicates each mathematical formula based upon trigonometry for each sub-step. It also introduces how to use the tables. Note also that the tables in the *Lixiang kaocheng* are much more complex. In other words, the author of the *Rgya rtsis snying bsdus* simplified the steps, the sub-steps in the steps, tables, etc., which may mean

669 Lunar parallax ($\pi_☽$) influences the possibility, magnititude, and timing of mid-eclipse, half-duration, etc., in the case of a solar eclipse. It depends on the longitude (λ) and latitude (φ) at observer's position. In the *Lixiang kaocheng*, three differences (Ch. *sancha* 三差), i.e. *gaoxiacha*, *dongxicha* (Ch. 東西差. lit. east-west difference. > T. *shar nub dman cha'i bar khyad*), and *nanbeicha* (Ch. 南北差. lit. north-south difference. > T. *lho byang dman cha'i bar khyad*) are calculated for $\pi_☽$. The *gaoxiacha* is calculated first. From the *gaoxiacha*, the *nanbeicha*, which influences the latitude, magnititude, etc. and the *dongxicha*, which influences the timing, are calculated. For the research into $\pi_☽$ in the *Mā yang rgya rtsis*, see Huang and Chen (1987a: 620-45). For an explanation in the *Lixiang kaocheng*, which is the same with *Mā yang rgya rtsis* in terms of theory and practice of eclipse calculation, see He et al. (1985: 319-31, 684b). For modern research, see Chen (1990: 121-4). Zhang1 (2014: 178-200), which is an excellent research into it. The following formular has been given in Zhang1 (2014: 184): *dongxicha* = atan (cos (*baidao gaohu jiaojiao*) × tan (*gaoxiacha*)). *nanbeicha* (*nanbeicha*) = asin (sin (*baidao gaohu jiaojiao*) × sin (*gaoxiacha*)). — the value of the *baidao gaohu jiaojiao* depends on φ. — The methodological approach to the parallax calculation in the *Lixiang kaocheng* was well established. In the case of the *dongxicha*, when the moon is on the west of the nonagesimal (= *baipingxiangxian*) (= true moon is ahead of apparent moon), time difference is added; when the moon is on the east of the nonagesimal (= apparent moon is ahead of true moon), time difference is substracted. For the same approach, see Vince in note 664. In the case of the *nanbeicha*, the values vary according to the relative position (south or north) of the *baipingxiangxian* to the zenith. For an excellent explanation of the method in English, see Swerdlow and Neugebauer (1984: 278-82) based upon Copernicus.

that he was very familiar with calculating and using this algorithm.

Another apsect of the *Lixiang kaocheng* (also reflected in the *Mā yang rgya rtsis*) is that it is based upon geographical / geometric knowledge based upon real measurements. For example, lunar eclipse step 9: calculation of magnititude (Ch. *shifen* 食分 / T. *'dzin cha*) (step 11 in the case of solar eclipse) is as follows:

Table 43.

	Lixiang kaocheng (655b - 656b)	Huang and Chen (1987:) / (1987:)
Lunar Eclipse	*taiyang judi* (太陽距地) the distance of the sun to the earth	
Lunar Eclipse	*taiyin judi* (太陰距地) the distance of the moon to the earth	
Lunar Eclipse	*taiyin banjing* (太陰半徑) semi-diameter of the moon.	*zla phyed* ([56]). Table {*tha*}: *zla ba'i phyed srid kyi re'u mig.*[670]
Lunar Eclipse	*diying banjing* (地影半徑)[671] semi-diameter of earth's shadow	*grib ma'i phyed srid* ([57]). Table {*da*}: *grib ma'i phyed srid kyi re'u mig.* *grib ma'i dman cha* ([58]). Table {*na*}: *grib ma'i dman cha'i re'u mig.* *nges pa'i grib ma* ([59]) = ([57]) – ([58]).
Lunar Eclipse	*bingjing* (並徑) summation of the diameters	*'dzin mtshams bar khyad* ([60]) = ([56]) + ([59]).
Lunar Eclipse	*shifen* (食分) magnitude	*'dzin cha bar khyad* ([61]). *'dzin cha* ([62]).

[670] The semi-diameter of the sun (Ch. *taiyang banjing* 太陽半徑 / T. *nyi phyed*) and that of the moon (Ch. 太陰半徑 / T. *zla phyed*) influence eclipse limit and magnititude. For the size of the apparent semi-diameter of the sun and moon with respect to the distance between the sun and moon and the earth in the *Lixiang kaocheng*, see Zhang1 (2014: 121).

[671] For the method of the *Lixiang kaocheng*, see Zhang1 (2014: 131-2).

The semi-diameter of the sun (Ch. *taiyang banjing* 太陽半徑. T. *nyi phyed*) and the moon (T. *zla phyed*) influnces eclipse limit and magnititude. Most of all, the size of the apparent semi-diameter of the sun and moon should be found with respect to the distance between the sun and moon and the earth.[672] Such elements in the *Lixiang kaocheng* (also reflected in the *Mā yang rgya rtsis*) for calculation of magnititude, which are based upon real observations and measurements by astronomical instruments, is a contrast to *skar rtsis*. In the case of *skar rtsis*, the calculation of magnitude is not based upon geographical knowledge and techniques such as lunar declination, distance to the moon, semi-diameter of the sun and moon, parallax, etc.. It is based upon observational and empirical values.[673]

RELATIONSHIP BETWEEN THE *RGYA RTSIS CHEN MO* AND THE *MĀ YANG RGYA RTSIS*

The *Mā yang rgya rtsis* also uses basically the same method for parallax calculation as the *Rgya rtsis chen mo*. However, the method using a nonagesimal is commonly used in

[672] For the explanation in the *Lixiang kaocheng*, see Zhang1 (2014 : 121).

[673] For example, Dharmaśrī's (1983: 252-3) *Gser gyi shing rta*, which shows a typical Tibtan method, is as follows: Judge according to the division of the integers (*chu tshod*) given by the calculation (= longitude of the moon — *sgra gcan gdong* or *sgra gcan mjug*) by 5. Then, the degree of each obscuration is as follows: 1, 2, 3: total (T. *ril bor sgrib*), 4: almost total (white (= not obscured) part remains), 5: about $\frac{5}{6}$ (= $\frac{1}{6}$ remains), 6: $\frac{2}{3}$, 7: $\frac{1}{2}$, 8: $\frac{1}{3}$, 9: $\frac{1}{6}$, 10: $\frac{1}{8}$, etc. The total value of magnititude of a lunar eclipse is 10 *cha*. For the information, see also Henning (2007: 108-9). The method in the *Mā yang rgya rtsis* is a sharp contrast to that in *skar rtsis*.

Manchu dynasty astronomy that is based upon Western Jesuit astronomy. Then, it is natural that a mathematical continuation is seen also in the Tibetan translations, the *Rgya rtsis chen mo* and the *Mā yang rgya rtsis*. It the Pope catholic?

I showed that the *Mā yang rgya rtsis* derives constants, tables (See chapter 3), algorithm, etc. from the *Lixiang kaocheng*. Additional evidence that there is no textual relationship between the *Rgya rtsis chen mo* and the *Mā yang rgya rtsis* is difference in terminology. Some specific expressions can be highlighted:

Table 44. Terms for the coordinate system:

Chinese / English	*Tngri-yin udq-a / Rgya rtsis chen mo*	*Mā yang rgya rtsis*
huangdao (黄道): ecliptic	*sir-a ǰam / lam ser po*	*gnam thig ser po*
tianding (天頂): zenith	*tngri-yin orui/ gnam gyi gtsug*	*dkyil gnam*
gaodu (高度): altitude	*öndür qonuγ / zhag mthon po*	*mtho zhag*

Table 45. Terms for the position of the sun and moon:

Chinese / English	*Tngri-yin udq-a / Rgya rtsis chen mo*	*Mā yang rgya rtsis*
yinshu (引數): argument	*uduriduγči toγ-a / 'dren grangs*	n/a. the value of *rang 'gros* is the argument.
shijing (實經): true longitude	*maγad γulduγarγu qonuγ / nges pa'i dkyus zhag*	*dkyus zhag* is used to mean longitude.
dingshuo (定 朔): true conjunction	*toγtaγaγsan sin-e /gtan bzhag gi tshes*	*dag tshes*

Table 46. Terms for parallax:

Chinese / English	*Tngri-yin udq-a / Rgya rtsis chen mo*	*Mā yang rgya rtsis*
gaoxiacha (高下差): diurnal parallax	*öndür boγuni-yin dutaγu / mtho dma'i dman pa*	*dus cha chen po*
huangpingxianxiandu (黄平象限): nonagesimal	*sir-a tübsin baidal-un quγuča / ser po snyoms babs kyi thun*	*bgrod mnyam dkyil*

Table 47. Terms for eclipse:

Chinese / English	*Tngri-yin udq-a / Rgya rtsis chen mo*	*Mā yang rgya rtsis*
chukui (初虧): first contact	*toγtam qoruγdaqu / thog mar grib pa*	*'dzin mgo ('dzin 'go)*
shishen (食甚): mid-eclipse	*ülemǰi bariqui / rab tu 'dzin pa*	*'dzin rdzogs*
fuyuan (復圓): last-contact	*tügürig bolqu / zlum por 'gyur pa*	*btang zin*

Two observations can be highlighted from the texutal research sketched in the above tables: 1) there are remarkable differences in translating the same Chinese terms between the *Rgya rtsis chen mo* and the *Lixiang kaocheng.* Then, is it reasonable to argue that the *Mā yang rgya rtsis* evolved from the *Rgya rtsis chen mo*? 2) while the renderings of the *Rgya rtsis chen mo* are verbatim renderings from the Mongolian *Tngri-yin udq-a*, those of the *Mā yang rgya rtsis* are based upon a certain understanding of the Chinese methods and Chinese language. Unfortunately, a theoretical understanding of Chinese astronomy by the latter is not read from the *Rgya rtsis snying bsdus.*

Before ending this section, it should be stressed that the *Mā yang rgya rtsis* is not an astronomical system, but just a technique for eclipse calculations (especially for a solar eclipse, given the incorporated factors such as parallax, semi-diameter, etc.) from the *Lixiang kaocheng*. It is a duplication of the algorithm in the *Lixiang kaocheng*. It is not theoretical at all. It has no theory about the planets. Further, there is little theory on the sun and moon.[674] It just shows how to use the tables. Thus, it cannot be viewed as having

[674] For example, [26]-[35] in Huang and Chen (1987a) show the process calculating true sun from mean sun without explaining the theoretical bases. For the solar motion in the *Lixiang kaocheng*, see Ōhashi (2007: 663-

the same status as *skar rtsis* with coverage of astronomical expositions and calculation methods.

2.2. TIBETAN WAY OF UNDERSTANDING THE CHINESE ECLIPSE CALCULATION METHODS

2.2.1. UNDERSTANING OF THE CHINESE METHODS ON THE BASIS OF THE *SKAR RTSIS*

The *Mā yang rgya rtsis* is of Chinese origin. However, it should be stressed that it is not a simple duplication of the *Lixiang kaocheng*. Rather, it is a Tibetanized Chinese system in terms of the change of the values at epoch (*rtsis 'go*) according to *skar rtsis* method, the calculation of *zla dag*, use of monthly *dhru ba* values and daily mean values of the sun and moon, use of integers, etc.. In other words, the *Mā yang rgya rtsis* can be understood within a broader frame and in the context of Tibetan attempts to understand the eclipse calculation of a neighboring tradition.

EPOCH DATA, *ZLA DAG*, CONVERSION OF EPOCH

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5) and Wang (2013: 439-43): the sun's motion is explained on the basis of the geometric model using deferent (*bentian* 本天) and double epicycles (*benlun* 本輪).

The Chinese calendar, including the *Lixiang kaocheng*, begins the year at the winter solstice (Ch. *dongzhi* 冬至. T. *dgun nyi ldog*). The epoch in the *Lixiang kaocheng* is Elhe taifin Kangxi 23rd year *jiazi tianzhengdongzhi* (甲子（1684）天正冬至).[675] However, the *Mā yang rgya rtsis* begins the year at 12/0 according to *grub rtsis*.[676] A *mchan bu* given by anonymous4 reads as follows:[677]

> *lugs 'di'i zla ba'i dang po hor zla bcu gnyis pa rgyal gyi zla ba yin pas ... / dus 'khor pa rnams kyang zla grangs kyi ang rtags hor zla'i grangs dang mthun par 'bri srol yod pas 'dir yang de dang mthun par ngo thog gi grangs*[678] *kyis bsgyur bas chog par byas so /*[679]
>
> Because the first month of this tradition (= *Mā yang rgya rtsis*) is the 12th *hor* month, i. e. *rgyal zla*, ... because *Kālacakra* adherents also has the method of calculating the numbers of months in accordance with the numbers of *hor zla*, it is fine to multiply by the current numbers also for this (= *rtsa ba'i dhru wa* ((monthly) root quantities)[680] in the context) in accordance with it (= *hor zla*).

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[675] For this term, see Ōhashi (2011: 160).

[676] This may be misleading: 12/0 belongs to the previous year of the epoch year. For more explanation, see below note 682.

[677] I use anonymous4 to denote the person who added some *mchan bu*s in the original manuscript retyped in Huang and Chen (1987a). He must be a different person from the author of the *Rgya rtsis snying bsdus*.

[678] The *ngo thog gi grangs* means the current number. For example, if it is the second month currently, the number is 2. It equals *'das zla* + 1.

[679] Huang and Chen (1987a: 356). For the calculation of epoch data at winter solstice in the Chinese calendar, see Sivin (2009: 71). Sivin (2009) is a research into *Shoushili*, Yuan period calendar, but the calculation methods of elements relevant to epoch are basically the same with the *Lixiang kaocheng*, one of the Qing calendars.

[680] For this, see below pp. 322-3.

The epoch of the above text, i.e. the *Rgya rtsis snying bsdus*, is 1743/12/0[681] according to the Tibetan *grub rtsis* calendar. Or, it may be said that it basically begins from winter solstice like Chinese lunar calendar.[682]

Next, the calculation of the *zla dag*. The *Rgya rtsis snying bsdus* calculates *zla dag* according to *skar rtsis* method, which is the first step for the calculations of the *rtsa ba'i dhru wa lnga* calculation. Ser chen Zhabs drung mentions,

> *... dang po zla dag sgrub tshul ni / thun ṭi khri lo gsum pa'am / rab yid shing pho byi ba sogs / 'das lo gnyis bsgyur sngar lo yi / glang zla la sogs 'das zla bsres / gnas gnyis bzhag la 'og mig (2) bsgyur / mkha' me byin la mda' ros bgos / thob nor steng bsres zla dag go / 'di ni dus 'khor lugs dang bstun / rgya la zla dag brtsi srol med /*[683]

---

[681] I conjecture that since the epoch 1744 (*jiazi* year) was set in order to adjust the *rtsis 'phro* values to the *yingshu* values of the *Lixiang kaocheng* whose epoch is also a *jiazi* year (1684). It may have been written around the epoch, 1744, for real use.

[682] We need a understanding of the Chinese lunar calendar: *tianzhengdongzhi*, winter solstice of the immediately previous year of the year that will be calculated is set as a reference point. For example, Chinese lunar calendar 2015 (乙未)/11 (戊子)/12 (壬申) is winter solstice (= December, 22, 2015); Seen from 2016 (丙申)/ 1 (庚寅)/ 1 (庚申) (= February, 8, 2016), the winter solstice belongs to the previous year. To explain it by using 1744, the epoch of the *Rgya rtsis snying bsdus*, the winter solstice of the year 1743 ＝ the *tianzhengdongzhi* of the year 1744. However, note that the first *Mā yang rgya rtsis* text does not use the *tianzhengdongzhi* as epoch! It changes the epoch into 1743/12/0 according to *grub rtsis* by reflecting the calculational differences between 12/0 and the winter solstice of the year 1743. — In Huang and Chen (1987a: 353), "*jiazi,* the ninth year (1744) of Abkai wehiyehe Qianlong 乾隆." (*gnam skyong lo dgu shing byi*) means that the epoch date is 1743/12/0. — The *yingshu* (應數. equivalent to *rtsis 'phro* in Tibetan *skar rtsis* astronomy) has been adjusted to 1743/12/0 by *skar rtsis* method. From a different perspective, because the difference between 12/0 and winter solstice is already reflected in the system as *rtsis 'phro*, it may be assumed that the epoch of the *Mā yang rgya rtsis* system is still winter solstice like Chinese calendar. And meanwhile earlier *Mā yang rgya rtsis* texts use *shing byi* (Ch. *jiazi*) as epoch according to Chinese tradition, later *Mā yang rgya rtsis* texts use *me yos* as epoch according to the *skar rtsis* tradition by means of *rtsis 'go spos pa*. The *rtsis 'go spos pa* is also made according to *skar rtsis* method.

[683] Ser chen Zhabs drung (1861: 1b).

> ... firstly, as for the method of calculating *zla dag*, multiply by two (-> twelve)[684] the elapsed years from the third year of Yooningga dasan Tongzhi's[685] (T. *thun ṭi*) reign, i.e. the wood-male-mouse year (1864 C.E.)[686] of the 14th *rab byung*, add [the result] to the elapsed months from the ox month (*glang zla* = *rgyal zla*)[687], etc of the previous year. [ ] put two rows and multiply by 2, add 30 (= *rtsis 'phro* value), and divide by 65. Adding the quotient to the upper row (value) makes *zla dag*. This accords with the method of the *Kālacakra*, there is no calculation method of the *zla dag* in China.

As seen above, it is clear that *Mā yang rgya rtsis* calculates the *zla dag* according to the method of *skar rtsis*.[688]

In the following, I show the calculations of *zla dag* and winter solstice values in the *Mā yang rgya rtsis* with a focus on the difference from the Chinese system. The left column in the following table briefly shows the Chinese method. In fact, the steps in the Chinese systems including the *Lixiang kaocheng* are more complex. I just show the Chinese concepts to understand the Tibetan steps. For convenience sake, let me take the example of *grub rtsis* 2014 (T. *shing rta*)/8/15 [= *jiawu* (甲午) year (2014), 9th month *jiaxu* (甲戌), 15th

684 This is incorrect. This should be 12.

685 Man. Yooningga dasan / M. Bürintü ǰasaγči / Ch. Tongzhi 同治. (r. November 1861 – January 1875).

686 This means that the epoch is 1863/12/0.

687 This is a rare indication which explicitly states that *glang zla* is equated with the 12th month according to *Mā yang rgya rtsis* system. We need more materials to confirm this. For several equation methods between the name of month according to 12 animals and *nya skar gyi zla ba*, see above note 185.

688 For an example, see below p. 313.

day *renzi* (壬子) according to the Chinese lunar calendar for October 8, 2014]. The comparison table is as follows:[689]

Table 48.

Lixiang kaocheng	Bsam 'grub rgya mtsho (1987)[690]
zhongji (中積. "intermediate accumulation" in Sivin (2009)[691])	*'das lo*: $2014 - 1987 = 27$. *'das zla*: 8 months *zla dag*: $27 \times 12 + 8 + [(27 \times 12 + 8) \times 2 + \mathbf{57}^{692}] \div 65 = 343\frac{6}{65}$

689 The corresponding processes are arranged in the same row in this table. The left column in the above table shows how the date is found in the *Lixiang kaocheng* system. Note that the Chinese steps are much more complex. I simplified them to a considerable degree. My point is that the Chinese method is not the same with the Tibetan method. The latter is based upon the *skar rtsis* method as seen above.

690 I use ([]) in order to show the numberings given by Huang and Chen (1987a). The division ([1])-([10]) in the edition is strange. The contents are not properly given. Especially, ([8])-([10]) are problematic. It is not known whether or not they existed in the *Rgya rtsis snying bsdus*. Since the *Rgya rtsis snying bsdus* has never been made public, some philological and astronomical issues remain unsolved. Fortunately, some information on them is found in later texts, -for example, see Mkhyen rab nor bu (1943: 2a). To show all the components from ([1])-([10]), I use Bsam 'grub rgya mtsho (1987) whose epoch is 1986/12/0.

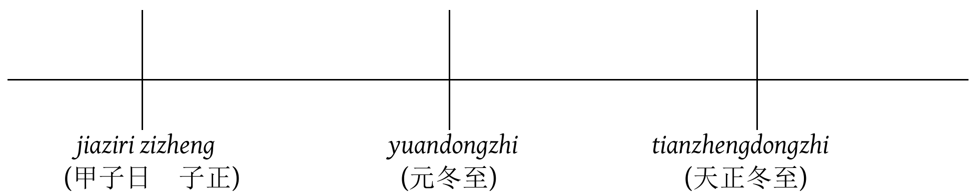
691 Sivin (2009: 429): "The Intermediate Accumulation is the number of day parts from winter solstice at the calendrical epoch to winter solstice of the current year." It should be noted that in Chinese calendars including the *Lixiang kaocheng*, *zhongji* is the number of days between *yuandongzhi* and *tianzhengdongzhi*. However, the *Mā yang rgya rtsis* calculates *zla dag* (the number of months) in accordance with the *skar rtsis* tradition.

692 This is the *skar rtsis* method as mentioned above. The boldic is *rtsis 'phro*. For 57, see Bsam 'grub rgya mtsho (1987: 2). The *rtsis 'phro* value in case that the epoch is 1986/12/0 in the tradition of the *Mā yang rgya rtsis* is different from that of *skar rtsis*. (Cf. 1986/12/0: *mda' ro lhag ma* is 61). Huang and Chen (1987a: 353): In the case of the *Mā yang rgya rtsis* whose epoch is 1743/12/0, the *rtsis 'phro* value is 10. (Cf. 1743/12/0 *grub rtsis*: *mda' ro lhag ma* is 12). Essentially, because the *Mā yang rgya rtsis* follows the intercalation method of the Chinese lunar calendar, the differences are followed.

Table 48 (continued)

tongji (通積 "series accumulation" (Sivin's (2009) term)) = *zhongji* + *qiying.* [693]	*lo 'pho'i zhag grangs.*[694] $27 \times 365 + (27 \times 60 + \mathbf{60}) \div 247$ [695] $= 9861\frac{198}{247}$

[693] The calculation of *tianzhengdongzhi* is displayed in the following diagram.



Yuandongzhi is the winter solstice (the epoch). *Jiaziri zizheng* is the midnight (Ch. *zizheng* 子正) of the first day in a sexagenary cycle (Ch. *jiaziri* 甲子日) immediately before the *yuandongzhi*. *Tianzhengdongzhi* is the winter solstice of the year which will be calculated. The inverval between *jiaziri zizheng* and *yuandongzhi* is *qiying* (氣應 "*qi* interval constant"). For more information on *qiying*, see Sivin (2009: 386): "the *Ch'i* (*qi*) Interval Constant is the interval from the beginning of the last sexagenary day cycle to the epochal winter solstice—in other words, the sexagenary date of the solstice." — In the *Tngri-yin uda-q*, it is rendered as *ayur-un neileče*; in the *Rgya rtsis chen mo*, it is rendered as *dbugs kyi 'grig pa*. — And for the concept of *ying* in the Chinese astronomy and the relevant diagram, see Sivin (2009: 373-4). For the reason why the *qiying* is needed, see Sivin (2009: 393): "The purpose of this procedure is to find the date (i.e. ordinal number of the day within the sexagenary cycle) of the winter solstice of the desired year." And the inverval between *yuandongzhi* and *tianzhengdongzhi* is *zhongji* (中積). The inverval between *jiaziri zizheng* and *tianzhengdongzhi* is *tongji* (通積).

[694] To understand the calculations, understanding of some concepts such as *lo 'pho* and *lo 'pho'i zhag* are necessary. Bsam 'grub rgya mtsho (2011: 119-20) [= *Bod rgya tshig mdzod chen mo* (2000: 2810) = Tshul khrims rgyal mtshan (2009: 369)]: the *lo 'pho*: "the border time between the completion of the previous year and the emergence of the new year." (*lo snga ma rdzogs pa dang phyi ma gsar du shar ba'i dus mtshams /*). The *lo 'pho'i zhag*: "day (*nyin zhag*) numbers elapsed before the winter solstice of the calculated year (= *tianzhengdongzhi*) of the border time at which the new epoch was set up (= 12/0. epoch)." (*rtsis 'phro spos mtshams nas brtsi bya'i gnam lo'i dgun nyi ldog yan chad la nyin zhag ci tsam song ba'i grangs yin /*). Also for the definition, see Bsam 'grub rgya mtsho (1987: 2). The *lo 'pho'i zhag* is used for the subsequent calculations of *nyi ma*, *skar ma*, *gza'*, *spar kha*, and *sme ba* of the *tianzhengdongzhi*, which will be explained below.

[695] For the number 60, see Bsam 'grub rgya mtsho (1987: 2). 53 is given in Huang and Chen (1987a: 353). The first *Mā yang rgya rtsis* text (= the *Rgya rtsis snying bsdus*) must have been produced by means of manipulating the Chinese *qiying*. The way it was drawn is worth studying. The number 53 may be that which was calculated in conformity with the *tianzhengdongzhi* of 1684 (= epoch of the *Lixiang kaocheng*) or the *tianzhengdongzhi* of 1723 (= epoch of the *Lixiang kaocheng houbian*).

Table 48 (continued)

tianzhengdongzhi ganzhi (天正冬至 干支)	*lo 'pho'i nyin de'i* (= *dgun nyi ldog nyin*) *nyi ma* (*nyi khams*): $(9861 + \mathbf{37}^{696}) \div 60 = 164\frac{58}{60}$ [697]

[696] 23 is given in Huang and Chen (1987a: 354). Likewise, the way 23 was drawn is worth studying.

[697] 58 falls on *renxu* in the Tibetan *Mā yang rgya rtsis* system, showing a difference from the Chinese one. Firstly, 60 *jiazi* (甲子) is used to count days in the Chinese calendar. The combination between 10 *tiangans* (天干): *jia* (甲), *yi* (乙), *bing* (丙), *ding* (丁), *wu* (戊), *ji* (己), *geng* (庚), *xin* (辛), *ren* (壬), *gui* (癸), and 12 *dizhis* (地支): *zi* (子), *chou* (丑), *yin* (寅), *mao* (卯), *chen* (辰), *si* (巳), *wu* (午), *wei* (未), *shen* (申), *you* (酉), *xu* (戌), *hai* (亥) makes 60. The Chinese 60 *jiazi* is presented as follows:

1	2	3	4	5	6	7	8	9	10
jiazi (甲子)	*yichou* (乙丑)	*bingyin* (丙寅)	*dingmao* (丁卯)	*wuchen* (戊辰)	*jisi* (己巳)	*gengwu* (庚午)	*xinwei* (辛未)	*renshen* (壬申)	*guiyou* (癸酉)
11	12	13	14	15	16	17	18	19	20
jiaxu (甲戌)	*yihai* (乙亥)	*bingzi* (丙子)	*dingchou* (丁丑)	*wuyin* (戊寅)	*jimao* (己卯)	*gengchen* (庚辰)	*xinsi* (辛巳)	*renwu* (壬午)	*guiwei* (癸未)
21	22	23	24	25	26	27	28	29	30
jiashen (甲申)	*yiyou* (乙酉)	*bingxu* (丙戌)	*dinghai* (丁亥)	*wuzi* (戊子)	*jichou* (己丑)	*gengyin* (庚寅)	*xinmao* (辛卯)	*renchen* (壬辰)	*guisi* (癸巳)
31	32	33	34	35	36	37	38	39	40
jiawu (甲午)	*yiwei* (乙未)	*bingshen* (丙申)	*dingyou* (丁酉)	*wuxu* (戊戌)	*jihai* (己亥)	*gengzi* (庚子)	*xinchou* (辛丑)	*renyin* (壬寅)	*guimao* (癸卯)
41	42	43	44	45	46	47	48	49	50
jiachen (甲辰)	*yisi* (乙巳)	*bingwu* (丙午)	*dingwei* (丁未)	*wushen* (戊申)	*jiyou* (己酉)	*gengxu* (庚戌)	*xinhai* (辛亥)	*renzi* (壬子)	*guichou* (癸丑)
51	52	53	54	55	56	57	58	59	60
jiayin (甲寅)	*yimao* (乙卯)	*bingchen* (丙辰)	*dingsi* (丁巳)	*wuwu* (戊午)	*jiwei* (己未)	*gengshen* (庚申)	*xinyou* (辛酉)	*renxu* (壬戌)	*guihai* (癸亥)

Secondly, the Tibetan *jiazi* in the case of the *Mā yang rgya rtsis* = Chinese 60 *jiazi* − 1.

0	1	2	3	4	5	6	7	8	9
T. *shing byi* (Ch. *jiazi*)	*shing glang* (*yichou*)	*me stag* (*bingyin*)	*me yos* (*dingmao*)	*sa 'brug* (*wuchen*)	*sa sbrul* (*jisi*)	*lcags rta* (*gengwu*)	*lcags lug* (*xinwei*)	*chu sprel* (*renshen*)	*chu bya* (*guiyou*)
10	11	12	13	14	15	16	17	18	19
shing khyi (*jiaxu*)	*shing phag* (*yihai*)	*me byi* (*bingzi*)	*me glang* (*dingchou*)	*sa stag* (*wuyin*)	*sa yos* (*jimao*)	*lcags 'brug* (*gengchen*)	*lcags sbrul* (*xinsi*)	*chu rta* (*renwu*)	*chu lug* (*guiwei*)
20	21	22	23	24	25	26	27	28	29
shing sprel (*jiashen*)	*shing bya* (*yiyou*)	*me khyi* (*bingxu*)	*me phag* (*dinghai*)	*sa byi* (*wuzi*)	*sa glang* (*jichou*)	*lcags stag* (*gengyin*)	*lcags yos* (*xinmao*)	*chu 'brug* (*renchen*)	*chu sbrul* (*guisi*)
30	31	32	33	34	35	36	37	38	39
shing rta (*jiawu*)	*shing lug* (*yiwei*)	*me spre'u* (*bingshen*)	*me bya* (*dingyou*)	*sa khyi* (*wuxu*)	*sa phag* (*jihai*)	*lcags byi* (*gengzi*)	*lcags glang* (*xinchou*)	*chu stag* (*renyin*)	*chu yos* (*guimao*)
40	41	42	43	44	45	46	47	48	49
shing 'brug (*jiachen*)	*shing sbrul* (*yisi*)	*me rta* (*bingwu*)	*me lug* (*dingwei*)	*sa sprel* (*wushen*)	*sa bya* (*jiyou*)	*lcags khyi* (*gengxu*)	*lcags phag* (*xinhai*)	*chu byi* (*renzi*)	*chu glang* (*guichou*)
50	51	52	53	54	55	56	57	58	59
shing stag (*jiayin*)	*shing yos* (*yimao*)	*me 'brug* (*bingchen*)	*me sbrul* (*dingsi*)	*sa rta* (*wuwu*)	*sa lug* (*jiwei*)	*lcags sprel* (*gengshen*)	*lcags bya* (*xinyou*)	*chu khyi* (*renxu*)	*chu phag* (*guihai*)

Table 48 (continued)

	lo 'pho'i nyin de'i skar ma: $(9861 + \mathbf{19}$[698]$) \div 28 = 352\frac{24}{28}$[699]. *lo 'pho'i nyin de'i gza'*: $(9861 + \mathbf{3}$[700]$) \div 7 = 1409\frac{1}{7}$.[701] *lo 'pho'i nyin de'i spar kha*: $(9861 + \mathbf{2}$[702]$) \div 8 = 1232\frac{\mathbf{7}}{8}$.

For more information, see Bsam 'grub rgya mtsho (1987: 24).

698 see Bsam 'grub rgya mtsho (1987: 2)

699 The equation of 27 *rgyu skar*s in the *skar rtsis* with Chinese ones is as follows: 0 *tha skar* (equivalent to Ch. *lou* 婁), 1 *bra nye* (*wei* 胃), 2 *smin drug* (*mao* 昴), 3 *snar ma* (*bi* 畢), 4 *mgo* (*zi* 嘴), 5 *lag pa* (*can* 參), 6 *nabs so* (*jing* 井), 7 *rgyal* (*gui* 鬼), 8 *skag* (*liu* 柳), 9 *mchu* (*xing* 星), 10 *gre* (*zhang* 張), 11 *dbo* (*yi* 翼), 12 *me bzhi* (*zhen* 軫), 13 *nag pa* (*jiao* 角), 14 *sa ri* (*kang* 亢), 15 *sa ga* (*di* 氐), 16 *lha mtshams* (*fang* 房), 17 *snron* (*xin* 心), 18 *snrubs* (*wei* 尾), 19 *chu stod* (*ji* 箕), 20 *chu smad* (*dou* 斗), 21 *gro bzhin* (*niu* 牛), 22 *mon gre* (*xu* 虛), 23 *mon gru* (*wei* 危), 24 *khrums stod* (*shi* 室), 25 *khrums smad* (*bi* 壁), 26 *nam gru* (*kui* 奎). Because 28 *xiu* (宿) system is used in the Chinese calendar, *byi bzhin* (*nü* (女)) — placed between 21 *gro bzhin* and 22 *mon gre* — is not calculated in Tibet. For relevant information, see Huang (2002: 50-2), Henning (2007: 356-7, 362-3), Sivin (2009: 90-4). In the case of the *Mā yang rgya rtsis* system, it adopts 28 *xiu* system with different numbering from Chinese calendar: *jiao* = 0, *kang* = 1, *di* = 2, ... and finally *zhen* = 27. 20 falls on *can* (T. *lag pa*). See the following table in Bsam 'grub rgya mtsho (1987: 23).

0	1	2	3	4	5	6	7	8	9	10	11	12	13
T. *nag pa* (Ch. *jiao*)	*sa ri* (*kang*)	*sa ga* (*di*)	*lha mtshams* (*fang*)	*snron* (*xin*)	*snrubs* (*wei*)	*chu stod* (*ji*)	*chu smad* (*dou*)	*gro bzhin* (*niu*)	*byi bzhin* (*nü*)	*mon gre* (*xu*)	*mon gru* (*wei*)	*khrums stod* (*shi*)	*khrums smad* (*bi*)
14	15	16	17	18	19	20	21	22	23	24	25	26	27
nam gru (*kui*)	*tha skar* (*lou*)	*bra nye* (*wei*)	*smin drug* (*mao*)	*snar ma* (*bi*)	*mgo* (*zi*)	*lag pa* (*can*)	*nabs so* (*jing*)	*rgyal* (*gui*)	*skag* (*liu*)	*mchu* (*xing*)	*gre* (*zhang*)	*dbo* (*yi*)	*me bzhi* (*zhen*)

It should be noted that in the *Mā yang rgya rtsis*, Tibetan astronomers assimilated *ying* (*rtsis 'phro*), *jiazi*, *rgyu skar*, etc. in a Tibetan way. See above notes 682, 693, and 695.

700 See Bsam 'grub rgya mtsho (1987: 2).

701 1 = Sunday. In this case, it falls on December 22, 2013. The result of the *lo 'pho'i nyin de'i gza'* (Ch. *tianzhengdongzhi*) in the *Mā yang rgya rtsis* was adjusted to be identical with that of *skar rtsis.* In other words, the weekday values in the *Mā yang rgya rtsis*: 0 = Saturday, 1 = Sunday, 2 = Monday, 3 = Tuesday, 4 = Wednesday, 5 = Thursday, 6 = Friday.

Table 48 (continued)

	lo 'pho'i nyin de'i sme ba:[703] (9861 − **6**[704]) ÷ 9 = 1095.[705] i. e. 0 = 9 .

The *zla dag* is calculated from 12/0, not from the winter solstice in the method of *skar rtsis*. And the values of the winter solstice are calculated together. In other words, *lo 'pho'i nyin* is winter solstice ((*tianzheng dongzhi* 天正冬至) = Chinese lunar calendar 2013/11/20 [= December 22, 2013]). According to the above calculation, *nyi khams* (= *nyi ma*. Ch. *ganzhi* 干支) is *chu khyi* (Ch. *renxu*) which agrees with the Chinese lunar calendar.[706] The *skar ma* (Ch. *xiu* 宿) is *xing*, which is irrelevant to *skar rtsis*. The *gza'* (Ch. *yao* 曜) is Sunday, which is the same as *skar rtsis*. The *spar kha* (Ch. *gua* 卦) and *sme ba* (Ch. 宫) calculations[707] are

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702 See Bsam 'grub rgya mtsho (1987: 2).

703 ([7])-([10]) appear as only titles in Huang and Chen (1987a). They do not exist in the *Lixiang kaocheng* and the origin of them is dubious.

704 See Bsam 'grub rgya mtsho (1987: 2).

705 Bsam 'grub rgya mtsho (1987: 2): "The remainder after the division is also subtracted from nine." (*dor lhag gis kyang rtsa la phri*). In other words, if the remainder is 1: 9 − 1 = 8, 2: 9 − 2 = 7, 3: 9 − 3 = 6, 4: 9 – 4 = 5, 5: 9 – 5 = 4, 6: 9 − 6 = 3, 7: 9 – 7 = 2, 8: 9 – 8 = 1, 9: 9 – 9 = 0. Because the *dkyil 'khor* is 9, 9 equals 0.

706 For the calculations of the values of each day, see Bsam 'grub rgya mtsho (1987: 19-20).

707 Huang and Chen (1987a) does not present the *rtsis 'phro* values.

not from the Chinese system. – They are divinations of Chinese origin. However, it is not certain when they were incoporated into the *Mā yang rgya rtsis*. – They may have a close relation to the contemporary *nag rtsis* method.[708]

Tibetan commentators have expressed their opinions about the origin of the five elements, i.e. *nyi ma*, *skar ma*, *gza'*, *spar kha*, and *sme ba* values. For example, Ser chen Zhabs drung says that they are unnecessary for eclipse calculation, but necessary for *huangli*. He may be true, but I disagree here since the calculations of correct *tshes grangs* are a basic step for eclipse calculation. He may have meant that the correct *tshes grangs*, which is verified by the calculation of the winter solstice, is necessary, but the values of the five elements are unnecessary. If so, I would agree with him. Mkhyen rab nor bu's opinion on origin are as follows:

> *.. rgya nag hwang le la / nyin re'i gza' skar sme ba gsum / mi 'byung rgya la grags pa dang / bstun pa'i lag len rtsis rgyun du / snang phyir 'dir yang 'phro spo bgyis /*[709]

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[708] The Sde srid's *Vaiḍūrya dkar po* states that they were introduced from the Tang dynasty; see Macdonald (1963: 73-4). However, it is not certain whether or not the calculation methods used in earlier period (period of Tibetan Empire) are the same with those in later period (for example, the system after the 5th Dalai lama and the system used in *Mā yang rgya rtsis*) and whether or not the calculations of the contemporary *nag rtsis* are the same with those of the *Mā yang rgya rtsis*. More research is needed. See also pp. 14-6.

[709] See Mkhyen rab nor bu (1943: 2a)/ Kun dga' rig 'dzin and Phur bu don grub (1998: 572). There are many issues that have yet to be solved to understand this passage. For example, I am not sure what Mkhyen rab nor bu indicates by *rgya nag hwang le* (Chinese *huangli* < Ch. *huangli* 皇歷 or *huangli* 黄歷). In addition, according to him, there are no calculations of *gza'*, *spar kha* and *sme ba* in it. Is it a contemporary *wannianli* (萬年歷. T. *bskal li*) calendrical system? Moreover, I do not understand what tradition he mentions by *rgya la grags pa dang bstun pa'i lag len rtsis.* It may be *nag rtsis.* Anyway, he maintains a continuation of the caclulation methods of *gza', spar kha* and *sme ba*, by saying that they had existed in Tibet and were added by Mkhyen rab nor bu himself.

> … *gza'*, *spar kha*, *sme ba* of each day do not exist currently in the Chinese *hwang le* (< Ch. *huangli* 皇歴 / *huangli* 黄歴). I (= Mkhyen rab nor bu) changed the *rtsis 'phro* [of them] also here, because the practice, which accords with the one known in China, existed at all times.

He understands that the calculations of the *gza'*[710], *spar kha*, *sme ba* included in the later *Mā yang rgya rtsis* texts derive from the past. That is all. No more information is given in the above text. This leaves us with the question: how did Mkhyen rab nor bu change the *rtsis 'phro* for the five elements? Are they part of the contemporary *nag rtsis*? All in all, the key point is that the *Mā yang rgya rsis* is a tradition that compromises *skar rtsis* and a Chinese method: *skar rtsis* method for *zla dag*, mixture between *skar rtsis* and Chinese method for winter solstice values.

There is also another *skar rtsis* method the *Mā yang rgya rtsis* uses: *rtsis 'go spos pa.* We use the *Rgya rtsis snying bsdus*, three *Bsam 'phel dbang gi rgyal po*-s with different epochs to show how the epoch has been changed. The *rtsis 'phro* values for the *zla dag* calculation are as follows[711]:

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[710] The *gza'* value accords with that of the *skar rtsis*.

[711] *Rtsis 'go spos pa* has been made by the following calculations which evidence that the three *Bsam 'phel dbang gi rgyal po*-s with different *rtsis 'go*-s are basically the same calendar with the *Rgya rtsis snying bsdus*.

$1864 - 1744 = 120$	$1927 - 1864 = 63$	$1987 - 1927 = 60$
$120 \times 12 = 1440$	$63 \times 12 = 756$	$60 \times 12 = 720$
$\frac{1440 \times 2 + 10}{65} = 44.4615384615$	$\frac{756 \times 2 + 30}{65} = 23.7230769231$	$\frac{720 \times 2 + 47}{65} = 22.8769230769$
$44.4615384615 - 44 = 0.4615384615$	$23.7230769231 - 23 = 0.7230769231$	$22.8769230769 - 22 = 0.8769230769$
$0.4615384615 \times 65 = \mathbf{30}$	$0.7230769231 \times 65 = \mathbf{47}$	$0.8769230769 \times 65 = \mathbf{57}$

Table 49.

Rgya rtsis snying bsdus. Huang and Chen (1987a: 276-7). Epoch: 1744. 1743/12/0	Ser chen Zhabs drung (1861: 1b). Epoch: 1864. 1863/12/0	Mkhyen rab nor bu (1943: 1b). Epoch: 1927. 1926/12/0[712]	Kun dga' rig 'dzin and Phur bu don grub (1998: 571). Epoch: 1987. 1986/12/0[713]
10	30[714]	47	57

UNITS, *DHRUBA*, AND ARITHMETIC

Investigating the lunar eclipse, the first step is the calculation of the mean motion at the mean full moon day (Ch. *pingwang zhu pingxing* 平望 諸平行) and that of the solar eclipse, the first step is the calculation of the mean motion at the mean new moon day (Ch. *pingshuo zhu pingxing* 平朔 諸平行 [715]). I will show how the Tibetans apply the *skar rtsis* measurement units and concepts such as *rtag longs* and *rtsis 'phro* to understand the Chinese concept of *yingshu*. Firstly, basic constants of the movements of the sun and moon are as follows:

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[712] In this text, the epoch was changed by Mkhyen rab nor bu into 1927 from Ser chen Zhabs drung (1861) (epoch: 1864) and the *mjug byang* was added by him.

[713] The epoch of this text was changed by Kun dga' rig 'dzin and Phur bu don grub into 1987 from Mkhyen rab nor bu (1943) (epoch: 1927).

[714] The numbers in Ser chen Zhabs drung (1861) are unreadable. It is based upon my calculation.

[715] The step numbers given here follow the *Lixiang kaocheng*. For the information, see above note 654.

Table 50.

	rtag longs per *tshes zhag*
synodic month 29^{d}12^{h}44'3"3"'111"" (30/24/60/60/60/360) (= 29.53059 days)[716]	29^{d}12^{h}44'3"3"'111"" (30/24/60/60/60/360) ÷ 30 = 23^{h}37'28"6"'39""21""' (24/60/60/60/360/30) = 0^{z}59^{q}3'4"18"' (7/60/60/6/707)[717]
nyi spyi 29°6'24"15"'103"" (30/60/60/60/360) [718]	29°6'24"15"'103"" (30/60/60/60/360) ÷ 30 = 58'12"48"'183""13""' (60/60/60/360/30) = 0^{k}4^{q}21'5"51"' (27/60/60/6/67)[719]
nyi rang 29°6'19"9"'242"" (30/60/60/60/360) [720]	29°6'19"9"'242"" (30/60/60/60/360) ÷ 30 = 58'12"38"'116""2""' (60/60/60/360/30) = 0^{k}4^{q}21'5"46"' (27/60/60/6/67)
zla rang 0^{g}25°49'0"3"'317"" (12/30/60/60/60/360) [721]	0^{g}25°49'0"3"'317"" (12/30/60/60/60/360) ÷ 30 = 12°51'38"0"'46""17""' (30/60/60/60/360/30) = 0^{k}57^{q}52'2"7"' (27/60/60/6/67)[722]

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[716] This value is used for the *tshes dhru* which is the interval between epoch and the mean new moon (Ch. *pingshuo* 平朔) in which a solar eclipse occurs.

[717] Compare this with that of the *grub rtsis* value: 0^{z}59^{q}3'4"16"' [= 29.53059 days]. See above p. 195. Both are nearly the same. This kind of similarity may have convinced Tibetan astronomers of understanding the Chinese method introduced as the *Mā yang rgya rtsis* through the lens of *skar rtsis*.

[718] The *nyi ma'i spyi 'gros* (= *nyi spyi*. Ch. *taiyang pingxing* 太陽平行) means the monthly mean movement of the sun. The value equals 104784".2547685. See above p. 157.

[719] Compare the value of the sun's mean movement per lunar day in the *grub rtsis*: 0^{z}4^{q}21'5"43"'; see above note 504.

[720] The *nyi ma'i rang 'gros* (= *nyi rang.* Ch. *taiyang zixing* 太陽自行) means the sun's angular motion (solar anomaly) from the perigee on a monthly basis. — the equation of the center of the sun is 0 at perigee. For the information, see Evans (1998: 226-7). — The value equals 104779".1612037; see Huang and Chen (1987a: 524) and above p. 157.

[721] The z*la ba'i rang 'gros* (= *zla rang*. Ch. *taiyin zixing* 太陰自行) means the moon's angular motion (lunar anomaly) from the perigee on a monthly basis. The value equals 92940".064675925; see Huang and Chen (1987a: 524) and above p. 157.

[722] Compare the *zla ba'i rtag longs* (*tshes zhag*) value of the *Phug pa grub rtsis* whose daily movement is 0^{z}58^{q}21'5"43"'; see above p. 196.

Table 50 (continued)

rā gdong $1^{g}0°40'13''55'''167''''$(12 /30/60/60/60/360) [723]	$1^{g}0°40'13''55'''167''''$(12 /30/60/60/60/360) ÷ 30 = 13°1'20"27"'305""17""' (30/60/60/60/360/30) = $0^{k}58^{q}36'0''14'''$ (27/60/60/6/23)

As seen above, Tibetan *Mā yang rgya rtsis* astronomers transformed the modern measurement units used in the *Xiyang xinfa lishu* into the *skar rtsis* measurement units. Although they did not use the latter units in real calculations, they compared and contrasted the *Mā yang rgya rtsis* values according the familiar *skar rtsis* values. Secondly, the calculations of root quantities are based upon *skar rtsis* approach and methods, i.e. calculating a monthly value and then calculating a daily value, which is different from Chinese methods.[724] Concretly, *rtsa ba'i dhru wa lnga* ([11])-([15]) are monthly values like *dhru ba* values in *skar rtsis* (*gza' dhru*, *nyi dhru*, etc.). The calculations are as follows:

The *rtsis 'phro* values (equivalent to the Chinese *yingshu*) are all those at epoch:

([11]) *rtsa ba'i tshes dhru* = *zla dag* × $29^{d}12^{h}44'3''3'''111''''$ + *rtsis 'phro.*

([12]) *nyi ma'i spyi 'gros dhru wa* = *zla dag* × *nyi ma'i spyi 'gros* [= 29°6'24"15"'103""] + *rtsis 'phro*.

([13]) *nyi ma'i rang 'gros dhru wa* = *zla dag* × *nyi ma'i rang 'gros* [= 29°6'19"9"'242""] + *rtsis 'phro*.

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723 The *rā gdong bar khyad* means the moon's monthly motion with respect to the *sgra gcan gdong* (= *rā gdong*). The value equals 110413".924398248; see Huang and Chen (1987a: 524) and above p. 157.

724 For the method in the *Lixiang kaocheng*, see He et al. (1985: 649-50). This falls beyond the scope of this work.

([14]) *zla ba'i rang 'gros dhru wa* = *zla dag* × *zla ba'i rang 'gros* [= 25°49'0"3"'317""] + *rtsis 'phro*.

([15]) *rā gdong bar khyad dhru wa* = *zla dag* × *rā gdong bar khyad* [= 1^{z}25°49'0"3"'317""] + *rtsis 'phro*.

And then, ([16])-([20]) are mean daily values at new moon and ([21]-[25]) are mean daily values at full moon, which are parallel values such as *gza' bar, nyi bar*, etc. in *skar rtsis*. The *nya yi dhru wa* is used for the calculation of [21]-[25]. For example, [21] = [11] + $\frac{1}{2}$ × 29^{d}12^{h}44'3"3"'111"" [= 14^{d}18^{h}22'1"32"'].[725] Overall, the writer of the *Rgya rtsis snying bsdus*

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[725] The half-month values (T. *nya yi dhru wa* (root quantity at full moon day) < Ch. *wangce* 望策) are as follows:

	Rgya rtsis snying bsdus. Huang and Chen (1987a: 356) ([21])-([25])	Ser chen Zhabs drung (1861: 2b)	Mkhyen rab nor bu (1943: 3b)	Kun dga' rig 'dzin and Phur bu don grub (1998: 574)
values added to *tshes dhru* (root quantity at new moon day)	14^{d}18^{h}22'1"32"'	14^{d}18^{h}22'1"31"'236""	14^{d}18^{h}22'1"31"'235""15""'	14^{d}18^{h}22'1"31"'235""15""'
values added to *nyi spyi* at new moon	0^{z}14°33'12"8"'	0^{z}14°33'12"7"'232""	0^{z}14°33'12"7"'231""15""'	0^{z}14°33'12"7"'231""15""'
values added to *nyi rang* at new moon	0^{z}14°33'9"35"'	0^{z}14°33'9"34"'301""	0^{z}14°33'9"34"'301""0""'	0^{z}14°33'9"34"'301""0""'
values added to *zla rang* at new moon	6^{z}12°54'30"2"'	6^{z}12°54'30"1"'339""	6^{z}12°54'30"1"'338""15""'	6^{z}12°54'30"1"'338""15""'
values added to *rā gdong bar khyad* at new moon	6^{z}15°20'6"57"'	6^{z}15°20'6"57"'264""	6^{z}15°20'6"57"'264""0""'	6^{z}15°20'6"57"'264""0""'

The underlined part may not cause a large difference in calculational results but are not unproblematic: I have no idea why the other three are different from the *Rgya rtsis snying bsdus*, the original text of the three. As seen in the table, different radices are possible: 5 measurement units: (30(day)/24(hour. *dus*)/60(*thun*)/60(*srang*)/60(*cha*)), 6 measurement units: (30/24/60/60/60/360(*cha*)), and 7 measurement units: (30/24/60/60/60/360/30(*cha*)). They are already transformed to Tibetan notation of units.

and later commentators may have thought that basically, the *Lixiang kaocheng* system was not different from Tibetan *skar rtsis* in terms of units, monthly values, daily values of the sun, moon and *sgra gcan*. They appropriated the Chinese method.

We turn now to the use of integers. Tibetan astronomers are not used to using fractions. Their calculations are integer based. Therefore, when they encounter fractions in the *Lixiang kaocheng*, they transform them into integers by any possible means. For example, when calculating the equation / true motion of the sun and moon, they Tibetanized the values in the *Lixiang kaocheng*. For example, see the components for the calculations of the *spyi yi dus kyi bar khyad* ([28] < Ch. *pingjushi* (平距時)),[726] *zla ba'i nges pa'i rang 'gros* ([30]. < Ch. *taiyin shiyin* (太陰實引)),[727] *nyi ma'i nges pa'i spyi 'gros* ([36]. < Ch. *taiyang pingxing* (太陽平行)), etc..[728]

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[726] Huang and Chen (1987a: 385-6)'s explanation is compelling: the *Lixiang kaocheng* value for *yue ju ri yi xiaoshi pingxing* (月距日一小時平行) is $\frac{1828.''6121108}{3600''\ (1\ \text{hour})}$. — For this value, see He et al. (1985: 651a). — However, *Mā yang rgya rtsis* value is $\frac{9143}{18000}$, which was created by converting 1828".6121108 to an integer by multiplying 5, i.e. $1828''.6121108 \times 5 \approx 9143$. And $3600 \times 5 = 18000$. This explanation is also a firm evidence that the *Mā yang rgya rtsis* is created from the *Lixiang kaocheng*.

[727] Huang and Chen (1987a: 386-7) 's explanation is compelling: *taiyin yi xiaoshi pingxing* (太陰一小時平行) in the *Lixiang kaocheng* is $\frac{1959''7476542}{3600''\ (1\ \text{hour})}$. — For this value, see He et al. (1985: 651b) — The *Mā yang rgya rtsis* value $\approx \frac{871}{1600}$. The conversion method is as follows: $1959''.7476542 \div 2.25 \approx 871$, and $3600 \div 2.25 \approx 1600$.

[728] Huang and Chen (1987a: 388-9) 's explanation is compelling: *taiyang yixiaoshi zixing* (太陽一小時自行) in the *Lixiang kaocheng* is $\frac{147''8471049}{3600''\ (1\ \text{hour})}$. — For this value, see He et al. (1985: 653a). — The *Mā yang rgya rtsis* value $\approx \frac{2129}{51840}$. The conversion method is as follows: $147''.8471049 \times 14.4 = 2128.\ 99831056 \approx 2129$, and $3600'' \times 14.4 = 51840$.

Taken together, the *Mā yang rgya rtsis* is not a systematical approach to astronomy. It just presents an algorithm for eclipse calculation which derives from the *Lixiang kaocheng.* There are some later *Mā yang rgya rtsis* texts, but no further development and understanding of modern astronomy has been made. – This may indicate that Tibetans do not understand the basis of the calculations at all. – It may be claimed that after the *Mā yang rgya rtsis*, the Tibetan astronomy got out of the mere intuitive descriptions of geographical features that is seen in *skar rtsis*, but if they had had a firm understanding of the *Mā yang rgya rtsis*, the Tibetans themselves would have revised and created the values and tables based upon the longitude, latitude, nonagesimal in Tibetan areas in other for the system to work properly in Tibet for the calculation of a solar eclipse. But, this has never happend simply because they did not know theory and pratice which the *Mā yang rgya rtsis* is based upon.

In the same vein, the issue how to assess the author (= a Beijing lama) of the first work, *Rgya rtsis snying bsdus*, may be raised. When it comes to modern astronomy, he may have had an understanding of modern mathematics, but the text itself does not suggest this. At minimum, it is certain that he introduces the well-known methods for eclipse calculation in Beijing during his time. Certainly, his contribution was to introduce the method on how to use the tables as far as modern astronomy is concerned. We also give him credit for the renderings of Chinese technical vocabularies into Tibetan. As far as *skar rtsis* is concerned, his contribution is quite clear. Being equipped with *skar rtsis* knowledge, he adjusts the *rtsis 'phro* values to *yingshu* values of the *Lixiang kaocheng*. Because of his contribution, the *Mā yang rgya rtsis* came into being and has been equated with the *skar* *rtsis*. From another perspective, the boundary of the *skar rtsis* has broadened together with the emergence of the *Mā yang rgya rtsis*, which obviously shows Tibetan endeavors for assimilating and equating the Chinese method into Tibetan. Moreover, the *skar rtsis* succeeds in making sense of the different system within the frame of the time-honored *skar rtsis* / *Kālacakra* astronomy.

Finally, the *Mā yang rgya rtsis* was created for eclipse calculation (especially solar eclipse calculation). However, we have little knowledge about whether it was actually used in Tibet and whether it really improved the accuracy of eclipse calculation in Tibetan area, especially when compared with *skar rtsis* method. In conjunction with this, the concrete instances and exmples used in real history - including *skar rtsis* eclipse calculations - could be collected, investigated, and compared to modern astronomical / mathematical data, which may be now possible with just one click on many websites and with software. Through those processes, we would be able to clarify the venue, time, etc. of the values which appear in Tibetan texts, whether they were calculated or observed. We have a long way to go.

CONCLUSION

Philosophy and religion respond to science by their own means.[729] In the Tibetan context, the religious and philosophical *Kālacakra* system incorporated astronomical elements, which may be regarded as science in a modern sense, through the logic of the *phyi nang gzhan gsum*. Since my writing concerned some concepts for eclipse calculations in the *skar rtsis* formulated from the *Kālackara*, I conclude by discussing the relationship between the *Kālacakra* and *skar rtsis* in terms of the folding and unfolding of the astronomical concepts in the *Kālacakra*.

The religious and philosophical schemes in the first chapter of the *Kālacakra* are combined with astronomical and cosmological expositions for the outer world, interrelated to the other chapters by using the same terms and concepts to explain both religion / philosophy and astronomy / mathematics. In other words, the *Kālacakra* attempts the paradoxical connection, intersecting religion and astronomy with orientation and methodology, respectively. The *para* (< G. παρά) literally means two/ multiple directions. It is also self-referential in that the undifferentiated conceptual link

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[729] Deleuze, tr. Patton (1994: xvi): "Every philosophy must achieve its own manner of speaking about the arts and sciences, as though it established alliances with them. It is very difficult, since philosophy obviously cannot claim the least superiority, but also creates and expounds its own concepts only in relation to what it can grasp of scientific functions and artistic constructions. A philosophical concept can never be confused with a scientific function or an artistic construction, but finds itself in affinity with these in this or that domain of science or style of art. The scientific or artistic content of a philosophy may be very elementary, since it is not obliged to advance art or science, but it can advance itself only by forming properly philosophical concepts from a given function or construction, however elementary. Philosophy cannot be undertaken independently of science or art."

between religion and astronomy ultimately completes the religious system, which is classified into the most supreme tantra in the Tibetan taxonomy of the Buddhist texts. It inevitably denotes its own "sense" by itself.

Meanwhile, *skar rtsis* is in a different situation. It forms relations with the *Kālacakra*: it participates in critical investigations into it, shares explanations with it, and ultimately creates a new ground for the *Kālacakra*. Concretely, it extracts astronomical / mathematical elements from the undifferentiated and paradoxical religious and astronomical concepts in the *Kālacakra*. Consequently, the mathematical and philosophical concepts, methodologies, etc. in the *Kālacakra* are inevitably resystemized, reorganized for the sake of calculation. And *skar rtsis* transforms the religious and astronomically abstract concepts of the *Kālacakra* into tangible and quantitative ones. Such justification of the abstract in the *Kālacakra* leads us to the world of arithmetic, replete with concrete mathematical, but not religious experiences. Conversely, the *Kālacakra* secures its reality through *skar rtsis*. The *Kālacakra* is restrengthened by it. The recursive binary structure between the *Kālacakra* and *skar rtsis*, which may be termed unfolding and folding, postulates the supreme authority of the *Kālacakra*.

Under such circumstances, eclipse calculation in the *skar rtsis* is essentially a study of mathematical concepts formulated and articulated in the *Kālacakra*. Because of the lack of information in the *Kālacakra*, empirical components are merged, but it is still conditioned by the *Kālacakra*. The interplay as the two conflicting elements unfold is reified as a paradoxical connection in real calculations.

Eclipse calculation is religious in terms of the multiplication of paradoxes. Tibetan astronomers, who are equipped with knowledge of the *Kālacakra*, reconcile the calculations based upon the *Kālacakra* and those based on Buddhist texts. *Kālacakra* adherents have devised the *bstan rtsis*, which is supported by the religious frame that the accuracy of a certain system is guaranteed by the accurate calculation of the lunar eclipse at the Buddha's enlightenment. They reconcile Buddhist chronological information in some Buddhist texts with their *skar rtsis* systems for the link between astronomy/ math and religion, which are mutually regulated and restricted. The paradoxical connection is the basis of the multiplication of meanings. However, contradiction is inevitable between the *Kālacakra* and the texts which do not fit the *Kālacakra*. Possible interpretations of the *skar rtsis* and the Buddhist texts ruled out evidence that "sense" (meaning) is generated, with priority given to the *Kālacakra*.

The rite of *gso sbyong*, which concerns time-keeping, shows that paradoxical connections have been formed in conjunction with the phenomena of eclipse. The *zhag mi thub* based upon the concept of the accuracy of *skar rtsis* for the performance of *gso sbyong* is based upon religious lamas' reading of the *Abhidharma*. Their priority is religion, embracing *skar rtsis.* However, with the phenomena of eclipse verified by direct perception and the different date in Chinese astronomy, some astronomers in Amdo have suggested the logic of the *yul bstun gso sbyong*. In other words, when a contradiction between religious expositions and empirical observations and knowledge was caused by eclipse phenomena, the religious rite of *gso sbyong* was adjusted because of empirical evidence. The accuracy of a certain system has a close tie to empirical evidence. Various "game rules" (in Wittgenstein's sense) may exist, but the priority given to empirical components has compromised religious practice. However, the core fact is that the two contradictory concepts, *zhag mi thub* and *yul bstun gso sbyong*, are both affirmed. The "sensation" unfolds paradoxically.

The religiously framed paradox for eclipse calculation that arises in the relationship between religion and astronomy makes Tibetan astronomers improve / get rid of the circumstances in which the incongruity between the inaccuracy of *rtsis* and real phenomena is manifest (*mngon sum*). However, the *Kālacakra* cannot give an answer to individual astronomical phenomena and elements, especially in the case of eclipse. Simply, it does not include much information on eclipse calculation. The approaches and methods taken in the *skar rtsis* are to assimilate many knowledge sources under the rubric of the *Kālacakra*. The eighteenth century witnessed the various strata such as observation, empirical knowledge, and research ensued into different traditions and various media such as *myong byang*, *man ngag*, *dris lan*, and Chinese texts / word of mouth. Understanding a solar eclipse requires geographical and geometric knowledge. The *Tngri-yin udq-a* and the *Mā yang rgya rtsis* were designed with new modern astronomical knowledge and introduced by non-Tibetans (= Mongolian lamas) and Tibetans, respectively.

The paradoxical connections to the many sources have been resolved only in the sense of their being located in a bigger web of the *skar rtsis* and the *Kālacakra*. The *skar rtsis* affirms mulitiple solutions of explaining them within the boundary of the *Kālacakra*. The unfolding of the *skar rtsis* for eclipse calculation and the "sensation" attached to it is paradoxical. From a different angle, it shows the paradox of making sense of itself by means of many sources. Ironically, the process of assimilating different knowledge sources has enriched the astronomical meanings of *skar rtsis* and interpretations of the *Kālacakra*. The rearrangement and resystemization of the *skar rtsis* have created a world in which the *Kālacakra* overarches the whole conception and methods of the *skar rtsis* and even the *Mā yang rgya rtsis* of Qing Chinese origin. The following hermeneutics have supported this approach that makes sense of itself and others to reconcile them with the *Kālacakra*: Intention (T. *dgongs pa*) in the *Kālacakra* was applied to the components within the boundary of Tibetan astronomy. In addition, compatibility (T. *mthun pa*) has been presupposed for the relationship between *skar rtsis* and *rgya rtsis*. The *mthun pa* may be also subsumed under the *dgongs pa*. The *Kālacakra* is overarching.

In the same manner, the unfolding of the mathematical approach for eclipse calculation in *skar rtsis* is conditioned by the mathematical concepts in the *Kālacakra*. The application of *nur ster* and the mere change of *rtsis 'phro* and *stong chen 'das lo* are fundamentally associated with such concepts and ideas presented in the *Kālacakra* as *rtag longs* and *stong chen*. They are tied to enhancing the eclipse calculation results, and the change of longitude by the manipulations of them is essentially empirical, based on the observations of astronomical phenomena. In fact, there is no guarantee that the eclipse calculation would become accurate by merely changing them and most of all, there is no guarantee that they are the real reasons for the inaccuracy of eclipse calculation.

Being aware of the defect in the calculation of solar eclipse, Tibetans attempted paradoxical connections. They intertwined the Chinese tradition later known as the *Mā yang rgya rtsis*. They focused on "saving the phenomena." The new spatio-temporal measurement in eclipse calculations using different concepts and mathematical approaches, armored with geographical / geometric knowledge for solar eclipse was not a concern to them. The *skar rtsis* method framed by the *Kālacakra* was a tool to accept the non-religious Qing Chinese tradition. As a result, the *Mā yang rgya rtsis* nestles in a paradoxical stability between the *Kālacakra* and non-*Kālacakra* elements. The *skar rtsis* establishes the paradoxical relationship because of the unfolding of the *Kālacakra* elements.

All in all, the Tibetan religious and astronomical justification of the rationale involved in eclipse calculation is based upon the unequal relationship between the *Kālacakra* and non-*Kālacakra* elements. The *skar rtsis* affirms both and forms paradoxical relations. Two or more different "series" responded to each other and affluent meanings emerged ("sensation"). The "sensation" is the process of making sense of different elements in different "series". Thereby, the "sense" of *skar rtsis*/ *Kālacakra* expands. However, that is not all. The dynamics of the paradoxical connections have been embodied, oscillating between abstraction and concreteness between the *Kālacakra* and *skar rtsis*. It is a möbius strip traversing the entire loop and ending up at the starting point of the *Kālacakra*. "Saving the phenomena" is a task for Tibetan astronomers, and the *Kālacakr*a postulates the way to "save the phenomena" religiously and astronomically.

Deleuze might have summarized in this way if he had studied eclipse calculation in Tibetan *skar rtsis* / *Kālacakra* : "The Tibetan eclipse calculation is paradoxical, and thereby, it is perfectly logical. It has its own logic: the combination and arrangement of the components and connections in it are made possible because of paradoxical elements (aka “quelconque” (“*aliquid*”), “differentiator,” “fundamental blank,” “aleatory point,” (“point aléatoir”) etc.), which bring about the “event” (“évènement”) in which multiple bifurcation of meaning / “sense” (“sens”) is generated. The “becoming” of the “event” unfolds in a limitless way. The “sense” is not separate from paradox. The “non-sense” (“non-sens”) makes possible the “sensation.” I pay homage to the journey of the philosophy of the “event” and “becoming” in the Tibetan astronomy.” [730]

[730] Lastly, I would like to stress that since my reading is based mostly upon later period *skar rtsis* texts, the early period *skar rtsis* texts may lead us to a different scenario. Also, in the early period, the *Kālacakra* corpus is pivotal and central in terms of the formation of *skar rtsis*. In conjunction with that, we (current and future scholars who work and will work on the field of Indian and Tibetan astronomy/ astrology) need to completely translate the first chapter of the *Laghukālacakra* and *Vimalaprabhā*.

APPENDIX I.

UNSOLVED PROBLEMS IN THE MONGOLIAN 60-YEAR CYCLE

Here is the table of the equation of Chinese, Mongolian and Tibetan 60-year cycles.

Table 51.

T. *shing byi* (58)/ *mig dmar* (S. *raktākṣi*). M. *köke quluγan-a*. Ch. *jiazi* (甲子 (1)).	*shing glang* (59)/ *khro bo* (*krodhana*). *kökegčin üker*. *yichou* (乙丑 (2)).	*me stag* (60)/ *zad pa* (*kṣaya*). *ulaγan bars*. *bingyin* (丙寅 (3)).	*me yos* (1)/ *rab byung* (*prabhava*). *ulaγčin taulai*. *dingmao* (丁卯 (4)).	*sa ’brug* (2)/ *rnam byung* (*vibhava*). *sir-a luu*. *wuchen* (戊辰 (5)).	*sa sbrul* (3)/ *dkar po* (*śukla*). *siraγčin moγai*. *jisi* (己巳 (6)).
lcags rta (4)/ *rab myos* (*pramodadūta*). *čaγan mori*. *gengwu* (庚午 (7)).	*lcags lug* (5)/ *skyes bdag* (*prajāpati*). *čaγaγčin qoni*. *xinwei* (辛未 (8)).	*chu spre’u* (*chu sprel*) (6)/ *ang gi ra* (*āṅgīrasa*). *qar-a beči*. *renshen* (壬申 (9)).	*chu bya* (7)/ *dpal gdong* (*śrīmukha*). *qaraγčin takiy-a*. *guiyou* (癸酉 (10)).	*shing khyi* (8)/ *dngos po* (*bhāva*). *köke noqai*. *jiaxu* (甲戌 (11)).	*shing phag* (9)/ *na tshod ldan* (*yuva*). *kökegčin γaqai*. *yihai* (乙亥 (12)).
me byi (10)/ *’dzin byed* (*dhātṛ*). *ulaγan quluγan-a*. *bingzi* (丙子 (13)).	*me glang* (11)/ *dbang phyug* (*īśvara*). *ulaγčin üker*. *dingchou* (丁丑 (14)).	*sa stag* (12)/ *’bru mang* (*bahudhānya*). *sir-a bars*. *wuyin* (戊寅 (15)).	*sa yos* (13)/ *myos ldan* (*pramāthi*). *siraγčin taulai*. *jimao* (己卯 (16)).	*lcags ’brug* (14)/ *rnam gnon* (*vikrama*). *čaγan luu*. *gengchen* (庚辰 (17)).	*lcags sbrul* (15)/ *khyu mchog* (*vṛṣa*). *čaγaγčin moγai*. *xinsi* (辛巳 (18)).
chu rta (16)/ *sna tshogs* (*citrabhānu*). *qar-a mori*. *renwu* (壬午 (19)).	*chu lug* (17)/ *nyi ma* (*subhānu*). *qaraγčin qoni*. *guiwei* (癸未 (20)).	*shing spre’u* (18)/ *nyi sgrol byed* (*tāraṇa*). *köke beči*. *jiashen* (甲申 (21)).	*shing bya* (19)/ *sa skyong* (*pārthiva*). *kökegčin takiy-a*. *yiyou* (乙酉 (22)).	*me khyi* (20)/ *mi zad* (*vyaya*). *ulaγan noqai*. *bingxu* (丙戌 (23)).	*me phag* (21)/ *thams cad ’dul* (*sarvajit*). *ulaγčin γaqai*. *dinghai* (丁亥 (24)).
sa byi (22)/ *kun ’dzin* (*sarvadhārin*). *sir-a quluγan-a*. *wuzi* (戊子 (25)).	*sa glang* (23)/ *’gal ba* (*virodhin*). *siraγčin üker*. *jichou* (己丑 (26)).	*lcags stag* (24)/ *rnam ’gyur* (*vikṛti*). *čaγan bars*. *gengyin* (庚寅 (27)).	*lcags yos* (25)/ *bong bu* (*khara*). *čaγaγčin taulai*. *xinmao* (甲卯 (28)).	*chu ’brug* (26)/ *dga’ ba* (*nandana*). *qar-a luu*. *renchen* (壬辰 (29)).	*chu sbrul* (27)/ *rnam rgyal* (*vijaya*). *qaraγčin moγai*. *guisi* (癸巳 (30)).
shing rta (28)/ *rgyal ba* (*jaya*). *köke mori*. *jiawu* (甲午 (31)).	*shing lug* (29)/ *myos byed* (*manmatha*). *kökegčin qoni*. *yiwei* (乙未 (32)).	*me spre’u* (30)/ *gdong ngan* (*durmukha*). *ulaγan beči*. *bingshen* (丙申 (33)).	*me bya* (31)/ *gser ’byung* (*hemalambin*). *ulaγčin takiy-a*. *dingyou* (丁酉 (34)).	*sa khyi* (32)/ *rnam ’phyang* (*vilambin*). *sir-a noqai*. *wuxu* (戊戌 (35)).	*sa phag* (33)/ *’gyur byed* (*vikārin*). *siraγčin γaqai*. *jihai* (己亥 (36)).

Table 51 (continued)

lcags byi (34)/ *kun ldan* (*śārvarin*). *čaɣan quluɣan-a.* *gengzi* (庚子 (37)).	*lcags glang* (35)/ *'phar ba* (*plava*). *čaɣaɣčin üker.* *xinchou* (辛丑 (38)).	*chu stag* (36)/ *dge byed* (*śubhakṛt*). *qar-a bars.* *renyin* (壬寅 (39)).	*chu yos* (37)/ *mdzes byed* (*śobhana*). *qaraɣčin taulai.* *guimao* (癸卯 (40)).	*shing 'brug* (38)/ *khro mo* (*krodhin*). *köke luu.* *jiachen* (甲辰 (41)).	*shing sbrul* (39)/ *sna tshogs dbyig* (*viśvāvasu*). *kökegčin moɣai.* *yisi* (乙巳 (42)).
me rta (40)/ *zil gnon* (*parābhava*). *ulaɣan mori.* *bingwu* (丙午 (43)).	*me lug* (41)/ *spre'u* (*plavaṅga*). *ulaɣčin qoni.* *dingwei* (丁未 (44)).	*sa spre'u* (42)/ *phur bu* (*kīlaka*). *sir-a beči.* *wushen* (戊申 (45)).	*sa bya* (43)/ *zhi ba* (*saumya*). *siraɣčin takiy-a.* *jiyou* (己酉 (46)).	*lcags khyi* (44)/ *thun mong* (*sādhāraṇa*). *čaɣan noqai.* *gengxu* (庚戌 (47)).	*lcags phag* (45)/ *'gal byed* (*virodhakṛt*). *čaɣaɣčin ɣaqai.* *xinhai* (辛亥 (48)).
chu byi (46)/ *yongs 'dzin* (*paridhāvin*). *qar-a quluɣan-a.* *renzi* (壬子 (49)).	*chu glang* (47)/ *bag med* (*pramādin*). *qaraɣčin üker.* *guichou* (癸丑 (50)).	*shing stag* (48)/ *kun dga'* (*ānanda*). *köke bars.* *jiayin* (甲寅 (51)).	*shing yos* (49)/ *srin po* (*rākṣasa*). *kökegčin taulai.* *yimao* (乙卯 (52)).	*me 'brug* (50)/ *me* (*nala/anala*). *ulaɣan luu.* *bingchen* (丙辰 (53)).	*me sbrul* (51)/ *dmar ser can* (*piṅgala*). *ulaɣčin moɣai.* *dingsi* (丁巳 (54)).
sa rta (52)/ *dus kyi pho nya* (*kālayukta*). *sir-a mori.* *wuwu* (戊午 (55)).	*sa lug* (53)/ *don grub* (*siddhārtin*). *siraɣčin qoni.* *jiwei* (己未 (56)).	*lcags spre'u* (54)/ *drag po* (*raudra*). *čaɣan beči.* *gengshen* (庚申 (57)).	*lcags bya* (55)/ *blo ngan* (*durmati*). *čaɣaɣčin takiy-a.* *xinyou* (辛酉 (58)).	*chu khyi* (56)/ *rnga chen* (*dundubhi*). *qar-a noqai.* *renxu* (壬戌 (59)).	*chu phag* (57)/ *khrag skyug* (*rudhirodgārin*). *qaraɣčin ɣaqai.* *guihai* (癸亥 (60)).

To give some explanations for the understanding of the table, the cycle of the Chinese system begins in *jiazi*; that of the Tibetan system begins in *me yos*. That is why the numbers in the brackets are different. The two systems based upon 60-year cycles are used in Tibet: the upper row in the each cell is the *rab byung* (S. *prabhava*) system and the lower row is the system of Jovian cycle (S. *bṛhaspaticakra*) from *Bde mchog stod 'grel* which is a commentary to *Cakrasaṃvara*.[731] As there are different Tibetan renderings of the

[731] For the list of the years in the *Cakrasaṃvaratantra* included in Vajrapāṇi's *Laghutantraṭīkā*, see Cicuzza (2001: 65). See also Schlagintweit (1897: 642-3), Vogel (1964: 225-6), Schuh (1973a: 143-5), Newman (1998: 344-5), Tshe tan Zhabs drung (2007: 22), Henning (2007: 351-2), etc.

original sanskrit words in the latter system, it is much more complex than presented here.[732] For the Chinese system in the table, see Sivin (2009: 68-70).

The Mongolian sexagenary system (M. *saitur γaruγsan* / *masida γaruγsan* < T. *rab byung*) in the table features the color-animal based system with the principle of the harmony between *arγ-a* (T. *pho* / Ch. *yang* 陽) and *bilig* (T. *mo* / Ch. *yin* 陰) (M. *arγ-a bilig ǰokilduqu*) in which original color indicates *arγ-a* and (original color ＋ *čin*) indicates *bilig.* However, be careful! It is difficult to verify when the principle was fixed. It is found in later periods but not in the early one (sixteenth-seventeenth c.). Therefore, special care is needed to use the Mongolian list. Let me briefly expand upon this point.

Since it seems that the beginning of the Mongolian *saitur γaruγsan* system was not introduced to Mongolia until the political and religious alliance between Mongolia and Tibet under Altan Qaγan of the Tümed (1507-1582), I consulted some materials from that period.[733] Given the remaining literature, as far as I know, the earliest evidence of a possible use of the Tibetan *rab byung* system in Mongolia is the colophon of *Manǰusiri-yin ner-e-yi üneker ögülekü* (S. *Mañjuśrīnāmasaṃgīti.* T. *'Jam dpal mtshan brjod*) which is presumed to have been created in the late sixteenth century by Altan Qaγan's grandson Bayaγud

[732] For the information, see van der Kuijp (unpublished (1)).

[733] When the *saitur γaruγsan* system was first used in Mongolia is still unknown. We may be able to guess by investigating some possible sources. Because it looks that the system based upon only 12 animals according to the Chinese system had been used before the sixteenth century in Mongolia, the *saitur γaruγsan* system is immediately distinguishable.

baγatur dai qung taiǰi and his son Čos irgyamsu (< T. Chos kyi rgya mtsho ?) finds *čaγan taulai ǰil-ün arban nigen sara-da … .* "in the eleventh month of the white-hare year."[734] In it, the "*čaγan taulai*" is problematic. As seen in the table, there is no "*čaγan taulai,*" but there is *čaγaγčin taulai* (1591). I think that the principle of *arγ-a bilig ǰokilduqu* may not have been applied or fixed until the late sixteenth century when the colophon was written.

Another evidence of the use of the *saitur γaruγsan* system in the early seventeenth century is the records of Altan Qaγan's birth and death in *Erdeni tunumal neretü sudur* whose author is unknown and which might have beeen written in the early seventeenth century. In it, Altan Qaγan's birth is given as *γal qutuγtu em-e taulai ǰil-ün budaday-a*[735] *kökeler sara-yin γučin-a üker edür-tür… .* "on the thirtieth day of the twelfth lunar month, an ox day, in the fire blessed female rabbit year".[736] His death is given as *čaγan moγai ǰil-dür … kökeler sara-yin arban yisün-e bars edür-tür… .*[737] "in the white snake year … on the

[734] For the colophon, see *Mañjuśrīnāmasaṃgīti in Mongolian, Tibetan, Sanskrit and Chinese, and Sekoddeśa in Tibetan and Mongolian,* Ed. Raghu Vira (19??: 230).

[735] ?. Kollmar-Paulenz's (2001: 154, 231) suggestion for *bodatai-a* is "wirklich." But, it does not look like a good solution.

[736] The English translation is given in Elverskog (2003: 77-8). For the interesting term *kökeler sara*, there has been a great deal of modern research in the west and the east. Among the western works, see Rybatzki (2003: 264-5).

[737] For the original phrases, see Anonymous2 (2007: 4a (birth), 37a (death)), Anonymous2 (1984: 28 (birth), 140-1 (death)), Anonymous2 (1991: 22, 196 (birth), 138, 284 (death)). Among the modern translations, Yoshida et al (1998: 13, 240) presents birth: February 1, 1508; Yoshida et al (1998: 78, 376) presents death: January 13, 1582. Kollmar-Paulenz (2001: 50-1, 154, 231): birth; Kollmar-Paulenz (84, 196, 316): death. Elverskog (2003: 77-8, 78. n.7, 224): birth: 1508; Elverskog (2003: 176. n. 335; 284): death: January 13, 1582. — Serruys (1958: 80-1) also points out the year of *Altan* Qaγan's birth and death on the basis of Chinese materials. — Among them, no research make sense of the Mongolian dates. Especially, Yoshida et al's (1998:

ninteenth tiger day of the twelfth month."[738] The "*čaγan moγai*" is a problem. It does not exist in the table. It is indicated as *čaγaγčin moγai* (1581) according to the table. In addition, I think that the principle of *arγ-a bilig ǰokilduqu* may not have been established until the early seventeenth century. Another intriguing issue in the phrases is that the five-element system of *γal* (T. *me*), *sirui* (T. *sa*), *temür* (T. *lcags*), *usu* (T. *chu*), *modun* (T. *shing*), together with the division between *er-e* (male) / *em-e* (female) [= five element + male/female] was used with the color-animal based system (-> see the phrase indicating his death). See his birth, in which not *ulaγčin taulai* (= 1507. the color-animal based system), but *γal qutuγtu em-e taulai ǰil* (= 1507. the element-male/female system) is given. In other words, the phrase indicating his birth is an example of the early seventheenth century Mongolian use of the division between male (T. *pho*) and female (T. *mo*) and the

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240) dates reckoned from Qing Chinese calendar cannot be justified: according to Qing Chinese calendar, 1507/12/30 does not exist. In other words, January 31, 1508 (Monday) [= *dingmao* (丁卯) year, *guichou* (癸丑) month (small month composed of 29 days), *wuxu* (戊戌) day] falls on 1507/12/29, and February 1, 1508 (Tuesday) [= *wuchen* (戊辰) year, *jiayin* (甲寅) month, *jihai* (己亥) day] falls on 1508/1/1]. January 13, 1582 (Saturday) [*xinsi* (辛巳) year, *xinchou* (辛丑) month, *jiyou* (己酉) day] falls on 1581/12/19]. Yoshida et al (1998: 240), which reiterates Morikawa (1987: 114), knows that 1507/12/30 does not exist in Qing Chinese lunar calendar. However, it suggests that 1507/12/30 is a mistake of 1507/12/20. The ground is as follows: 20 resembles 30 in Mongolian handwriting and the twentieth day is also an ox day. Are this kind of arbitrary corrections justified? Huang and Shen (2005: 185-6) points out that in the late sixteenth century (possibly in the early seventeenth century, given the date of the *Erdeni tunumal neretü sudur*), Tibetan day reckoning system, in which the first day falls on tiger (T. *stag*) or monkey (T. *spre'u*) day, the twentieth day is chicken (T. *bya*) or hare (T. *yos*) day, and the thirtieth day is sheep (T. *lug*) or ox (T. *glang*) day, was being used. In other words, the fact that the thirtieth day is an ox day is not strange. Rather, the twentieth day cannot be an ox day in the Tibetan day-reckoning system. Whether or not we accept Huang and Shen's (2005) argument, Morikawa (1987: 114) and Yoshida et al (1998: 240) cannot be accepted. It is also difficult to know which Tibetan system Mongolians used for day reckoning at that time. The same scenery unfolded in Tibet. *Phug pa*'s m = 1B was used according to Schuh (1973a) in the early seventeenth century? We do not have evidence.

[738] The translation is given in Elverskog (2003: 176).

five elements like the Tibetan *rab byung* system. Taken together, the color-animal based system and the system based upon the five elements coexist in *Erdeni tunumal neretü sudur.* In the case of the former, the principle of *arγ-a bilig ǰokilduqu* in the table is not applied. [739]

Another example of the Tibetan *rab byung* system in early seventeenth century Mongolia is the inscription (1624) of Čoγtu Taiǰi (1581-1637).[740] *sčaγan takiy-a ǰil-ün namur-un ekin sarayin* (*sic. read sar-a-yin*) *qorin nigen-e ... .*[741] "on the twenty-first day of the first autumn month of the white-chicken year (1621)." Again, the *čaγan takiy-a* is problematic. It should be *čaγaγčin takiy-a* (1621) according to the table. The date of the inscription was founded is given as follows: *Činggis qaγan-i törügsen usun morin ǰil-eče inaγsi dörben ǰaγun ǰiran dörben ǰil boluγsan-a ǰil-ün eki modun quluγana ǰil sarayin eki γal bars sarayin arban tabun yeke čaγan edür-e ... .*[742] "on the big white day, which is the fifteenth day, of the fire-tiger month which is the first month [in] the wood-mouse year (1624) which is the first year,

[739] The combination of the two systems may have later evolved into the color-animal based system with the principle of the harmony between *arγ-a* and *bilig.* If an animal is taken from the color-animal based system and male or female is taken from the five element system combined with male/female, the color-animal based system with the principle of the harmony between *arγ-a* and *bilig* is possible. However, I have no evidence at all.

[740] The inscription has been recently researched again and transcribed in Ц. Баттулга, Ё.Жанчив, et al, 2005. *Цогт хунтайжид холбогдох бичгийн дурсгалууд* (*эх бичгийн судалгаа*), *Corpus Scriptorum, Tomus III*. It is not available to me.

[741] See Vladimirtsov (1884-1931) (1926: 1254).

[742] Vladimirtsov (1926: 1259-60).

when it became the 464th year[743] after the water-horse year (1162) when Činggis qaγan (possibly 1162-1227) was born, … .” In this case, the year reckoning is based upon the five-element system. See *usun morin ǰil* and *modun quluγana ǰil.* In other words, it is verified that the two systems were being used together in early seventeenth century Mongolia and the principle of *arγ-a bilig ǰokilduqu* in the table was not applied.

In summary, given these examples[744] in the initial stage of the introduction of the Tibetan system, possibly in the late sixteenth (perhaps at the latest) / early seventeenth century, the color-animal system and five-element system seem to have been co-used for rendering the Tibetan *rab byung* system. It seems that in the early period, the clear division between color (Ch. *yang*) and color + *čin* (Ch. *yin*) has not been made. In other words, the use of the color-animal system based upon the *arγ-a bilig ǰokilduqu* seems to have been fixed later.

Lastly, I have several doubts. The Mongolian translation of the *Altan Γanǰuur* completed in 1628-1629 (note that it was already being used in the early seventeenth century) where the Mongolian *Laghukālacakra* has been included, may have influenced on the practice of the *saitur γaruγsan* system in Mongolia. Or, the beginning of the Mongolian

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[743] The arithmetic is strange, but the translation is according to the Mongolian sentence.

[744] I used very limited textual evidence. So, my conclusion is tentative. A fundamental problem is that not many Mongolian texts or inscriptions have survived. And each region may show a different method and tradition. In other words, the examples may not represent the use of entire Mongolian regions. For example, it is certain that the Tibetan *rab byung* system began to be used at the latest in the sixteenth century. Then, where in Mongolia? In conjunction with the gravity of the question, Ölǰeibayar (2004) suggests on the basis of Mongolian chronicles created during the period of Čing ulus that Mongolian chronicles use many different calendars such as Chinese and Tibetan. Different systems have been used during the same period in different regions and there is no uniform system.

saitur γaruγsan system may be coupled with the transmission of the Tibetan *skar rtsis* (M. *odun-u ǰiruqai*) in Mongolia. Howevver, we do not know when the Mongolian tradition of the *odun-u ǰiruqai* began in Mongolia.

APPENDIX II.

THE PREFACE OF THE *TNGRI-YIN UDQ-A*[745]

[*Tngri-yin udq-a* (1990: 1); *Tngri-yin udq-a* (1711: 1)] *Kitad-un ǰiruqai-yin sudur*[746]*-ača mongγolčilan orčiγuluγsan ǰiruqai-yin orusil.*

The preface of the astronomy translated into Mongolian from a text of Chinese astronomy.

Erte enedkeg-ün oron-dur dotuγadu yosun-u ǰiruqai kiged γadaγadu yosun-u ǰiruqai kemekü qoyar ǰüil boluγad γadaγadu yosun-u ǰiruqai inu, šakimuni burqan yirtinčü-dür ögede bolqu[747]*-yin uridača delgeregsen aǰuγu, dotuγadu yosun-u ǰiruqai-yi čaγ-un kürdün-eče nomlaγsan anu, burqan yirtinčü-dür ögede bolǰu, čaγ-un kürdün-ü ündüsün-i nomlaγsan-u qoyin-a delgereǰüküi,*

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[745] *Tngri-yin udq-a* (1711: 1-13) [= *Tngri-yin udq-a* (1990: 1-3)]. It should be noted that in the case of *Tngri-yin udq-a* (1711), the pagination is arbitrarily given by me according to the original print, because there are no page numbers in the print. The preface has already been translated twice: Matsukawa (1988: 40-62) in Japanese, and Huang and Shen (1988: 272-84) in Chinese. The former is a good translation which reflects Mongolian grammar—Mongolian is linguistically close to Japanese— and contains only some minor mistakes. The latter is relatively loose: the general idea is well presented but the rhetoric of Chinese makes the translation loosely tied to the Mongolian original text. Lastly, in contrast to the printer's colophon in the *Rgya rtsis chen mo* (see Appendix III), which is filled with Buddhist ideas and concepts such as *bstan rtsis*, this preface is relatively neutral to Buddhism, evincing criticism towards the inaccuracy of eclipse calculations in the *Kālacakra* / *skar rtsis*.

[746] The term *sudur* (S. *sūtra*) is generally used for Mongolian Buddhist texts. The Chinese astronomical texts *Xiyang xinfa lishu* (and maybe others) have nothing to do with Buddhism. Nevertheless, they are given the title *sudur* in Mongolian. In that sense, 'text' may be a better rendering for the term.

[747] Lessing (1960: 630): "*ögede bolqu*": "to pass away (honorific)". As will be clear in the colophon of the *Rgya rtsis chen mo*, this term seems to be related to the fact that the authors of the preface base themselves upon the *Phug pa* interpretation of the date of the Buddha's *Kālacakra* teaching. In the *Phug pa* tradition, the *Kālacakra* is regarded as the last tantra taught by the Buddha before his death. For more information, see chapter 1. Huang and Shen (1988: 274) incorrectly translate: "was born." Actually, "pass away" looks not to be a nice fit to the context. And Öbör mongγol-un yeke surγaγuli-yin mongγol kele bičig sudulqu tasuγ (1976: 276) [= Öbör mongγol-un yeke surγaγuli-yin mongγol sudulul-un küriyeleng-ün mongγol kele bičig sudulqu γajar (1999: 276)] presents *jialin* (驾临). "advent/ descent". In any case, the meaning is not generally well-understood.

Long ago in the land of India, two kinds [of astronomies] existed, called the astronomy of inner (Buddhist) principle and that of outer (non-Buddhist) principle. The astronomy of outer principle blossomed even before *Śākyamuni* Buddha passed away from the world; that which preached the astronomy of inner principle from the *Kālacakra* prospered after the Buddha passed away from the world, and [maybe Sucandra and the *Kālacakra* adherents] preached the *Kālacakratantra*.

kitad-un oron-dur olan qad-un üy-e boluγsan-ača obuγ iǰaγur adali busu, qorin qoyar üy-e-yin teüke deki qad-un üy-e-yin uridača, ǰiruqai delgeregsen boluγad, tedeger-ün üy-e-dür daraγ-a daraγ-a dalan qoyar ger[748] *olan ǰiruqayiči-nar*-[*Tngri-yin udq-a* (1711: 2)] *nuγud ber, naran saran graγ odun-u yabudal-ača möče terigüten-i bodalan taniqu yosun-i ariγudqan üiledbečü, endegürel ügei niγta-yi medeküi inü, todurqai ese bolǰuqui.*

Since the periods in which many emperors appeared in the land of China, astronomy has blossomed from the periods of the historical emperors of the twenty-two periods (dynasties) whose family origins are not the same; and although in their periods many astronomers, etc. of the successive seventy-two schools (?) purely performed the method of reckoning[749] time (M. *čaγ möče* < Ch. *shike.* lit. hour and minute),[750] etc. from the

[748] For the Mongolian term '*ger*,' Huang and Shen (1988: 274) suggest '*jia*' (家) meaning 'school, sect'. This choice may not be plausible in Mongolian because it just means 'tent, house.' However, I follow their rendering because the term does not make sense if it is translated as 'tent' and also because the fact that this text was written by Qing Mongolian scholars under the strong influence of Chinese scholarship should be taken into account.

[749] Two possibilities exist for rendering the strange term *bodalan taniqu*: 1. *bodala*. Lessing (1960: 108): "to count or number cattle by the head." In this case, the rendering could be 'reckon' 2. *bodatu.* Lessing (1960: 109): "material, tangible, substantial, concrete, real, original." In this case the rendering could be 'really recognize.' I think both of them would work. For *tani-*, see Lessing (1960: 778): "to know, to recognise, to be familiar with."

[750] In this sentence, *čaγ* is missing. However it is confirmed from other sentences that the authors mean '*čaγ möče*', which seems to be a calque from the Chinese *shike* (時刻; hour and minutes.): '*čaγ*' is '*shi*' and '*möče*' is '*ke*.' Sivin (2009: 82) renders the terms as "double hour and marks"; he states: "twelve equal intervals (*shi* 時), which I translate "double-hour. ... equal marks (*ke* 刻), each equivalent to 14.4 minutes on a modern clock." This reflects the Yuan dynasty unit-system, which is based upon the 100 *ke* (刻) system. In the Manchu dynasty, the temporal units were changed to a 96 *ke* system. In other words, before the *Shixianli* was introduced, 1 day = 12 double-hours composed of 100 *ke*-s; 1 double-hour $8\frac{1}{3}$*ke*-s; and 1 *ke* = 14.4 minutes. After the *Shixianli* was introduced, 1 day = 12 double-hours composed of 96 *ke*-s; 1 double-hour = 8 *ke*-s; and 1 *ke* = 15 minutes. The *Xiyang xinfa lishu / Tngri-yin udq-a / Rgya rtsis chen mo* are based upon the latter.

motion of the sun, moon, planets, and stars, knowing accuracy without a mistake became unclear.

Töbed oron-dur γadaγadu dutuγadu yerüngki-yin ǰiruqai kemekü üile-yin ǰiruqai kiged, dotuγadu yerü busu-yin ǰiruqai kemekü siddi-yin ǰiruqai, qoyar büri erten-eče delgerebečü, naran saran tüidküi[751]*-yin čaγ möče terigüten-i γaǰar oron-u öndür boγuni kiged, naran saran erte orui urγuqui-yin kemǰiyen-dür onuǰu*[752] *bodalan*[753] *taniqu keregtei kemen nomlaγsan atala, γaǰar oron-u öndür boγuni-yin kemǰiyen-i* [*Tngri-yin udq-a* (1711: 3)] *üǰeküi*[754] *yosun-u arγ-a terigüten inü sudur-tur todurqai ese boluγsan-u tulada, ǰiruqayičin-nuγud-ber čaγ möče terigüten-i endegürel ügegüy-e onuqui anu berke boluγad,*

In the land of Tibet, each of the two, *byed rtsis* (M. *üile-yin ǰiruqai*), known as the astronomy common to outer and inner [principles], and *grub rtsis* (M. *siddi-yin ǰiruqai*), known as the astronomy that is of inner [principle and] is not universal, has prospered from ancient times. However, at the same time there are those [texts] which explain that it is necessary to concretly recognize the *shike*, etc. of the solar and lunar eclipses, after one has understood by measurement the height of the place (= altitude) and the rise of the sun and moon in the morning and evening [respectively]. Because the methods, etc. of observing the level of the height of the place were not clear in the texts, astronomers had difficulty in unerringly understanding the *shike*, etc..

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[751] From the context, it looks to be the case that "*tüidküi*", meaning "obstruct", is rarely used for denoting eclipses. *Naran bariqu* for solar eclipse and *saran bariqu* for lunar eclipse are commonly used in Mongolian literature.

[752] It is difficult to translate "*kemǰiyen*" in "*kemǰiyen-dür onuǰu*". My suggestion is "measurement."

[753] This word is rarely seen. It may be related to "*bodatai*", meaning "concrete/ substantial."

[754] My suggestion for "*kemǰiyen*" in "*kemǰiyen-i üǰeküi*" is "level."

mongγol-un oron-dur ber[755] *töbed-eče orčiγuluγsan ǰiruqai delgeregsen bolbaču, čaγ möče terigüten-i bodalan taniqu berke inü mön kü tegün-lüge adali bolai, teyimü-yin tulada, manǰusiri degedü amuγulang qaγan, ǰiruqai-yin ǰüil-ün nab narin niγta bügüde-yi ker yosuγar kü ilerkey-e uqaγad, qamuγ ǰiruqayičin-a tusa bolqui-yi ayiladču, manǰusiri-yin adistidlaγsan kitad-un oron-dur* [*Tngri-yin udq-a* (1711: 4)] *delgeregsen ǰiruqai-yin γoul sudur-nuγud-ača sayitur aγsan-i čuγlaγul-un tegün-e todurqai ese boluγsan-u niγta-yi γarγaqu keregten-i sin-e nemeǰü, öber öber-ün oron γaǰar-un öndür boγuni-yin kemǰiyen-i üǰeküi yosun ba, naran saran graγ odun čaγ möče terigüten ab ali yambar büküi-yi endegürel ügegüy-e bodalan taniqu yosun-u niγta-yi todurqayiy-a γarγaγsan, ǰiruqai-yin γoul sudur-un sayin nomlalγ-a urida ügei egün-i, sin-e toγurbin kitad-un kele-iyer ǰokiyaγad, basa kü mongγol-un kelen-e orčiγulǰu keb-tür seyilge kemegsen* [*Tngri-yin udq-a* (1711: 5)] *ǰarliγ-i kičiyenggüyilen daγaǰu orčiγulbai.*

Although in the land of Mongolia, astronomy translated from Tibet has prospered, there is the exact same difficulty in reckoning *shike*, etc. For that reason, the Mañjuśrī Elhe taifin Kangxi Emperor, (M. Manǰusiri degedü (engke) amuγulang qaγan / Man. Elhe taifin)[756] having clearly grasped all the very delicate accuracy of [the different] kinds of astronomy exactly according to the principles, exclaimed (honorific) something which would become useful to all astronomers: "Newly add [the contents] necessary to bring accuracy to that which has become unclear in those nice texts, gathering it from the astronomical texts, the essence of astronomy, which has blossomed in the land of China blessed by Mañjuśrī. Then clearly bring out the method of observing the level of the height of each region, and the method of accurately reckoning shike of the sun, moon, planets, and stars, etc, whichever there may be, without any mistakes. Then newly edit and compose in Chinese this unprecedented good teaching, which stems from the astronomical texts, the essence of astronomy; then translate [it] into Mongolian again, and then carve [it] into blocks!" Being respectful of and following such a command, [we] have translated them.

Tenggerlig boγda manǰusiri degedü qaγan-u sin-e toγurbiγsan ba daki. tegünčilen naran saran graγ odun čaγ möče oron γajar-un öndür boγuni-yin niγta kemǰiy-e. terigüten-i onuqui ǰiruγ ba bodurul-un olan ǰüil ayimaγ-un nomlal-nuγud. tein kü üǰeküi surqui-dur ülemǰi čiqula keregten sudur-ud-i orčiγulǰu keb-tür seyilgebei. Manduγsan dumdadu yeke ulus kitad-un oron-dur. manǰusiri bodisadu-yin nomlaγsan uqaγan-u oron ǰiruqai-yi töbed-tür orčiγuluγsan olan bui-yin tula ba. maγad tegün-ü [*Tngri-yin udq-a* (1711: 6)] *mön činar manǰusiri qaγan öber-iyen*

[755] emphatic word.

[756] T. *bde ldan rgyal po* is given in the *Rgya rtsis chen mo*.

ǰokiyaγad mongγol-un kelen-e orčiγul kemegsen ǰarliγ-i dabquγ-a berke-yin tula. masi ariγun ünen čing sedkil-iyer bisiran daγan bayasulčaǰu čidaqui činegeber orčiγulbai. imaγta gün uqaγan-u oron ǰiruqai-yin sudur-ača sin-e toγurbiγsan boluγad. ilangγuγ-a manǰusiri-yin gün uqaγan-u dalai-yin töb-eče γaruγsan ba daki. iǰaγur-ača ulamǰilaγsan orčiγulγ-a ügei tulγur-iyar orčiγulqui-dur. iledte onun ülü čidaqui-yi yaγun ügülekü. Erdem-ten merged üǰeged buu sonǰiγtun. üǰegsen sonusuγsan čögen-eče masi čögeken[757] *boluγad. ülemǰi oyun bilig ber* [*Tngri-yin udq-a* (1711: 7)] *bidaγu moquduγ büküi*[758]*-yin tulada. üneker onun meden čidaqu inu asuru berke bolbaču. ütele üges-iyer učaraγsaγar uldaγsaγar orčiγuluγsan egüni. olan uqaγan-u oron-a suduluγsan merged üǰeged, udq-a činar-i sayitur uqan medeǰü ǰasaγtun. učaraǰu ǰöb boluγsan kedüi činegen bügesü tegün-iyer, osuldal ügegüy-e bügüde-de tusalan čidaqu boltuγai. Eyin orčiγuluγsan-iyar ǰiruqai-yin uqaγan-u qamuγ oron. endegürel ügei qotal-a γaǰar dakin-a sayitur delgereged. egüride öndürün keǰiy-e-ber batuda tegüs orosiǰu. egenegte olan bügüde-yin egeregsen küsel-i qangγaqu boltuγai.* [*Tngri-yin udq-a* (1711: 8)] *Engke amuγulang-un tabiduγar ǰil-ün naiman sar-a-yin sin-e-yin naiman-a kitad-un sudur-ača ekileǰü mongγolčilan baγulγabai.*

[We] translated the text (= *Xiyang xinfa lishu*) that had been newly edited by the heavenly holy Mañjuśrī Elhe taifin Kangxi Emperor, as well as the teachings of many kinds and categories of pictures and tables for realizing accurate measures, etc. of the *shike* of the sun, moon, planets, and stars, and of the height of the place, and similarly additional texts considered necessary for research, and carved [them] into printing blocks. Because in the land of China, the Middle Great Empire which prospered[759], there are many instances of astronomy, a field of knowledge preached by the bodhisattva Mañjuśrī having been translated into Tibetan, and because it is difficult to betray the command to translate [it] into Mongolian, as it was certainly something written by the Mañjuśrī

[757] It is difficult to literally translate the phrase *üǰegsen sonusuγsan čögen-eče masi čögeken*: *üǰegsen sonusuγsan* is a calque from the Chinese *jianwen* (見聞), meaning 'knowledge,' or literally '[what one] has seen and heard.' *čögen-eče masi čögeken* means 'extremely few from being few,' which means 'really few even while being few.' Taken together, I translate the phrase as 'extremely little knowledge.'

[758] The phrase *oyun bilig ber bidaγu moquduγ büküi* may look interesting to European readers. Firstly, it literally means 'wisdom [that] is stupid and dull,' which means 'stupid and dull.' Secondly, two synonyms are consecutively used: *oyun* is a synonym of *bilig*, while *bidaγu* is a synonym of *moquduγ.* This tradition looks to be related to the time-honored Uyghur literary tradition. For example, the phrase '*bilgä bilig*', in which each word meaning 'wisdom' is consecutively used, is seen in Uyghur Buddhist texts. - I think specialists of Uyghur Buddhism have a clear sense of this and all relevant issues which are currently beyond my ability. - Modern Uyghur calls it *jüp söz* (جۈپ سۆز), a paired word.

[759] The *manduγsan* is given in the Mongolian text. It is the past tense.

Emperor himself, [we] rejoiced with one another by respectfully following [this order] with very pure and truthful hearts, and have translated to the best of our ability. After newly editing the texts of astronomy, the absolutely deep field of knowledge, when [we] initially translated those [texts] which came especially from the center of the ocean of the deep intellect of the Mañjuśrī Emperor, as well as those yet-untranslated texts inherited from ancient times, need we even mention that we were unable to understand [them] clearly? May scholars and wise people not blame [us for this] when they are reading it! Because of [our] extremely limited knowledge, and furthermore our stupidity and dullness, although being able to truly know is very difficult, may those wise persons who have studied many of the fields of learning correct this one, which has been translated by finding simple (normal) terminology, by examining and clearly knowing the principle and essense! If there is something corrected by [your] finding, may it be useful to all without fault! By means of this text, thus translated, may the entire field of astronomy prosper well and unmistakenly throughout every place, and may it exist permanently, incessantly, always, firmly and perfectly, and may it always fulfill all that is hoped for! Starting from the Chinese text, we translated [this] into Mongolian on the eighth day of the eighth month in Elhe taifin Kangxi 50th year (1711 C.E.) (= September 20, 1711).

[*Tngri-yin udq-a* (1711: 9)] *orčiγuluγči kelemürčiner-ün ner-e inü.*

Names of the translators and interpreters.[760]

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[760] Throughout the Manchu dynasty (Man. Daicing gurun; commonly Qing dynasty), hundreds of Manchu and Mongolian astronomers were produced. This began from Elhe taifin Kangxi's (r. 1662-1722) concern for Western astronomy and science, and his insistence on teaching these subjects to Manchus and Mongolians of the eight banners (Man. *jakūn gūsa*). It is not difficult to find information on this subject. Citing Xi Yufu's (席裕福. ? - 1929) *Huangchao zhengdian leizuan* (皇朝政典類纂), *juan* (卷) 217: *Xuexiao Suanxuesheng* (學校 算學生), Li (1989: 37) shows that training in astronomy was provided to the Mongolian eight banners (Man. *monggo gūsa* / Ch. *baqi menggu* 八旗蒙古) at least from Elhe taifin Kangxi 9th year (1670), in equal measure to that given to the Manchu eight banners (Man. *manju gūsa* / Ch. *baqi manzhou* 八旗满洲) and the Chinese eight banners (Man. *ujen cooha gūsa* / Ch. *baqi hanjun* 八旗漢軍). Li (1989: 37) also cites the *Qingchao wenxian tongkao* (清朝文獻統考), *juan* (卷) 66 *Xuexiao San* (學校 三) to show that in Elhe taifin Kangxi 52nd year (1713), the Suanxueguan (算學館) was established at Mengyangzhai (蒙養齋) in Changchunyuan (暢春園), Beijing, and elected students from the eight banners received astronomy/ mathematics training there. As an example from a later period: the Menggu minzu tongshi bianweihui (2002: 471) indicates, based on the *Jiaqing Daqinghuidian* (嘉慶, Saicungga fengšen Jiaqing. r. 1796 ~ 1820. 大清會典), *juan*-s (卷) 64 and 65, that *shixianke* (時憲科) was established as a subsection of the Qintianjian (欽天監), while two Mongolian *wuguanzheng*-s (五官正), two Mongolian *boshi*-s (博士), and four Mongolian *tianwensheng*-s (天文生) were assigned to be responsible for the creation and publication of the Mongolian *shixianshu* (時憲書), the

töbed mongγol-un kereg-i ǰaγučilaγči[761] *dotuγadu sidar kiy-a rasi*[762]*. töbed mongγol bičig-ün ǰüil-dür suduluγsan boluγad, töbed bičig-ün surγaγuli-yin baγsi ǰasaγ-un lam-a danǰin gelüng. töbed*

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calculation of eclipses, and so on. This kind of imperial policy may help us understand the reason why Mongolian astronomers with knowledge of Western astronomy appear in the Preface of *Tngri-yin udq-a.*

[761] *ǰaγuči*: *Qaγan-u bičigsen tabun ǰüil-ün üsüg-iyer qabsuruγsan manǰu ügen-ü toli bičig* (1957: 1173). *ǰaγučilaγči* **:** Lessing (1960: 1024): "matchmaker ", "go-between."

[762] '*Dotuγadu*' and '*sidar*' literally mean 'inner' and 'close' respectively. Since I am not a specialist in the field of Mongolian law or politics, I am unsure whether or not the '*dotuγadu sidar*' is a part of the title *kiy-a*. **-** It literally mean 'one who exists closely to Emperor' like '*drung na 'khod pa*' (*drung na 'khod pa'i khyi ya bkra shis,* "*Kiy-a* Raši who exists in (Emperor's) presence") in the Tibetan printer's colophon of the *Rgya rtsis chen mo*. In the case of the term *kiy-a*, we have a clearer understanding: Serruys (1958: 91-2): ""*kiy-a*" is not a personal name, but the name of an office, or a title." It is defined in a Chinese text as "*shouling* (首領 foreman)", "an able manager in the court of a taiǰi, in charge of great and small affairs of the tribe." Lessing (1960: 465): "*kiy-a*: officer in the service of a prince; aid, bodyguard, page, adjutant; footman, orderly." Lessing (1960: 1215): "*ǰaγučin kiy-a*. imperial guard officer who reports on Mongolian affairs to the emperor." *Kiy-a*'*s* Manchu equivalent is *hiya.* See Norman (1978: 131): "guard, page, specifically an imperial guard who wore peacock feathers." Its Chinese equivalent is *shiwei* (侍衛). See Hucker (1985 : 430, no. 5333): "*shiwei* 侍衛 Imperial Guard or Imperial Guardsman." All in all, the title seems to indicate different Mongolian titles in different time periods, but it must refer to those persons who closely assisted emperors in the Qing dynasty. For Raši (aka Rasi) (?-1720s ?), see *Gongzhong manwen zhupi zouzhe* (宫中满文硃批奏摺) no. 24. at 1717 (Elhe taifin Kangxi 56th year)/7/1 (according to the Chinese lunar calendar), included in Suo and Guo. eds. (2004: 62-71). Furthermore, in the Mongolian colophon of the *Singqun Γanǰuur* in Red Ink completed in 1720, included in Čidaltu (2005: 187-8), he is mentioned among those persons in charge of the production of the *Γanǰuur* blockprint (M. *γanǰuur-un keb-i baiγulqu-yin ǰakiruγči*): *čiyan čüng min-i sidar aγči* (? . '*sidar*' seems to be a word which is related to '*dotuγadu sidar* (maybe *shiwei ?*).' Čidaltu's (2005) Mongolian computer input is not reliable) *terigün ǰerge-yin kiy-a raši.* ("The first-rank *shiwei* Kiy-a Raši at Qianqingmen 乾清門)." Nata (1991: 245-6): ... *tunglaγ* (C, D: *tungγalaγ.* For the different four editions of *Altan Erike*, see Nata (1991: the editor Čorǰi's preface, 1-4): there are differences in editions A, B, C, and D. A is an edition from Gandan Temple in Mongolia and Čorǰi has never seen it. B has been stored in Öbör mongγol-un neigem-ün sinjilekü uqaγan akademi-yin nom-un sang. The manuscript is composed of three volumes: first volume: 1b-45b, second volume: 1b-52b, and third volume: 1b-62b. C is three different editions (Mong 95, Mong 141, Mong 351) from the Royal Library in Copenhagen, Denmark. Among them, Mong 95 is complete, but several lines are missing in the case of its colophon. In the case of Mong 141 and Mong 351, many parts are missing and are in bad condition. D has been stored in Öbör mongγol-un nom-un sang (Ch. Neimenggu tushuguan): no. 01715. It is incomplete: being compared with the manuscript in Öbör mongγol-un neigem-ün sinjilekü uqaγan-u nom-un sang, the first volume and 1b-40b in the second volume are missing. But, the colophon is complete) *oγtarγui-yin egüden-ü* (B, C, and D has *terigün ǰerge-yin*) *kiy-a rasi ...* "(the first-rank officer) Kiy-a Rasi at Qianqingmen." According to Clark, Walravens, Krueger, Taube and Walter (2006: 12, no. 3), Raši, Danǰan [Danǰin is better], Arbidqu Abida, Sengge Arana, Sengge, Batuvčir, Misig, and Pürbü authored *The 36 Category Explanatory Dictionary* (M. *Γučin jirγuγatu tailburi toli*) (published year: ?). Among them, Raši, Danǰan

bičig-ün surγaγuli-yin baγsi arbidqu. mongγol ǰiruqayiči baγsi beki. mongγol-iyar orčiγuluγči baγsi očir. kitad bičig-i orčiγuluγči sumun-u ǰanggi dumbai. [*Tngri-yin udq-a* (1711: 10)] *kitad bičig-ün ǰiruqayiči qo guo zong. kitad ǰiruqayiči baγsi liu yu si. ǰiruqai-yi naribčilan nayiraγulǰu keb-i üǰejü seyilegsen dotuγadu yamun-u dedlegsen bičig-ün tüsimel očir. dedlegsen bičig-ün tüsimel laduγun. temdeglegči tüsimel sengge. temdeglegči tüsimel samadi. tölüglen kögegči*[763] *tüsimel arana.* [*Tngri-yin udq-a* (1711: 11); (1990: 3)] *aduγun-u daruγ-a sengge. ǰüngšü tüsimel baǰar. ǰüngšü tüsimel dunǰu. ǰüngšü tüsimel sereng. ǰüngšü tüsimel gendüsǰab. ǰüngšü tüsimel sambuuǰu. ǰüngšü tüsimel giyonǰu/giyünǰü. ǰüngšü tüsimel sereng.* [*Tngri-yin udq-a* (1711: 12)] *ǰüngšü tüsimel bandi. ǰüngšü tüsimel gowambuu. ǰüngšü tüsimel ǰünggüi. ǰüngšü tüsimel fiyantu. ǰüngšü tüsimel idam. ǰüngšü tüsimel čanglu. kin tiyen giyen yamun-u u gowan ǰeng tüsimel čangǰu. u gowan ǰeng tüsimel čangming.* [*Tngri-yin udq-a* (1711: 13)] *u gowan ǰeng tüsimel qo giyün si. u gowan ǰeng tüsimel buu ge čeng. boši tüsimel u čen. boši tüsimel Li šang gi. boši tüsimel šuu yün long. boši tüsimel ša du. tiyen wen šang fan ru ǰen.*[764]

Dotuγadu sidar Kiy-a (Ch. *shiwei* 侍衛) Raši (aka Rasi; Ch. Laxi 拉錫), a mediator of Tibetan-Mongolian affairs. Baγsi (teacher, instructor)[765] at the School of Tibetan (Ch. *Tanggutexue* 唐古特學. M. *Töbed bičig-ün surγaγuli*) and J̌asaγ-un lam-a Danǰin gelüng (T. Dge slong Bstan 'dzin) who studied Tibetan and Mongolian books and documents, et al.[766] Baγsi Arbidqu, instructor at the School of Tibetan. Baγsi Beki, Mongolian astronomer.

(Danǰin), Arbidqu Abida, Sengge Arana, and Sengge collaborated for the compilation of the *Tngri-yin udq-a*. He is further mentioned in any number of modern articles and books in Chinese. All in all, it is speculated that *dotuγadu sidar kiy-a* became a Mongolian high-officer in Elhe taifin Kangxi's favor, and was involved in many political, academic and religious activities related to Mongolia. Elhe taifin Kangxi must have consulted him about many issues related to Mongolia.

[763] '*tölüglen*': 'representative.' '*tölüglen kögegči*' is rarely found in Mongolian literature. A more commonly-used phrase is '*orulan kögegči*' ('the assistant of *ǰanggi*'. For *ǰanggi*, see below note 767). There are two for each *sumun*. See Oka (2007: 134-5), Lessing *(1960:* 622): 'lieutenant.'

[764] This transliteration is tentative. Generally, it is difficult to write Chinese names in Mongolian for phonetical reasons. Consequently, strange scripts are often introduced to write them in Mongolian.

[765] For the textual evidence of various usage and meaning of this term, see van der Kuijp (1995: 275-302).

[766] This lama appears in the printer's colophon in the *Rgya rtsis chen mo*. See below pp. 358-9.

Baysi Očir (S. Vajra), Mongolian translator. Adjutant in the Dumbai district,[767] Chinese Translator. Qo guo zong[768], Chinese astronomer. Baysi Liu yu si, Chinese astronomer.[769] Second rank civil officer at the Cabinet (M. *dotuγadu yamun*. Ch. *neige* 内閣) Očir, who carved the blocks after having carefully investigated and edited astronomy. Second rank civil officer Laduyun. Copyist (T. *yi ge pa*) officer-s Sengge (T. Seng ge) and Samadi (S. Samādhi). Lieutenant Arana. Commander of Horse Herds[770] Sengge (T. Seng ge). *Zhongshuguans*[771] Bajar (S. Vajra), Dunǰu (T. Don grub), Sereng (T. Tshe ring), Gendüsǰab (T. Dge 'dun skyabs), Sambuuǰu, Giyonǰu / Giyünǰü, Sereng, Bandi,[772] Gowambuu (T. Mgon po), J̌ünggüi, Fiyantu, Idam (T. Yi dam), and Čanglu. *Wuguanzhengs*[773] at Qintianjian[774]

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[767] M. *ǰanggi* (Man. *janggin* / Ch. *zhangjing* 章京) is adjutant / captain of the district (M. *sumun* / Ch. *zuoling* 佐領. For these terms, see Oka (2007: passim).

[768] This man seems to be He Guozong (何國宗. ? - 1767). However, *Qingshigao, Liezhuan* (列传) 70: 康熙五十一年进士 ... 命直内廷学算法. 五十二年，命编辑律历渊源."He [achieved] the rank of *jinshi* (Ch. 进士) [in the imperial exam] ... was ordered to study astronomy/ mathematics (算法) at the Palace in 1712. He was ordered to edit the *Sources of Musical Harmonics and Mathematical Astronomy* (Ch. *Lüliyuanyuan* 律历渊源) in 1713." This Preface was created in 1711. More detailed research on his life is necessary.

[769] He participated in the compilation of the *Rgya rtsis chen mo*, according to the printing colophon of the *Rgya rtsis chen mo*. I have no idea who he is.

[770] *Aduγun* (Ch. *Shangsiyuan* 上駟院). For "*aduγun-u daruγ-a*," see Szerb and Sárközi (1995: 265, no. 21): "superintendent of the herd." — "*aduγun-u darulγ-a*" is given therein. It seems to be a typographical error by Szerb and Sárközi. — Also see Hucker (1985: 413, no. 5064).

[771] For *zhongshuguan* (中書官), see Hucker (1985: 193, no. 1606).

[772] Bandi (Ch. 班第) which appears in Qing Chinese texts may derive from the Mongolian word Bandi which may be related to T. *ban dhe*. Actually, Bandi refers to a low-ranking monk in the Mongolian monastic hierarchy in the Manchu dynasty.

[773] For *wuguanzheng* (五官正), see Hucker (1985: 571, no. 7783), Xu ed. (2009: 262).

[774] The Qintianjian (欽天監) was the Bureau of Astronomy in the Manchu dynasty.

Cangǰu, Čangming (Ch. Changming 長命), Qo giyün si, and Buu ge čeng. Boshi[775] officials U čen, Li šang gi, Šuu yün long, and Ša du. Tianwensheng[776] Fan ru ǰen.

[775] For *boshi* (博士), see Hucker (1985: 389, no. 4746). Also see Hucker (1985: 510, no. 6727): *tianwen boshi* (天文博士).

[776] *tianwensheng* (天文生) is student and disciple of astronomy in the *Qintianjian*.

APPENDIX III.

THE PRINTER’S COLOPHON OF THE *RGYA RTSIS CHEN MO*

’Jam dbyangs bde ldan rgyal pos[777] *mdzad pa’i rgya rtsis bod skad du bsgyur ba’i spar byang /*

The printer’s colophon of the Tibetan translation of the Chinese Calculation composed by Mañjuśrī Kangxi Emperor.

[*shang* 1[a]] *Om swa sti / mthon mthing ral pa’i khur*[b] *’dzin gser gyi mdog / shes rab ral gri sher phyin glegs bam bsnams*[c] */ mi shes mun sel blo gros mchog stsol lha / ’jam pa’i dbyangs kyis rtag tu ’gro rnams skyongs / ngag gi dbang phyug ’jam dpal gzhon nu nyid / skye dgu’i bsod nams legs byas dpal yon du / ’khor los bsgyur ba’i rgyal po’i tshul bstan pa / bde ldan rgyal po’i zhabs zung spyi bos bsten / gang de’i blo gros yangs pa’i mkha’ dbyings las / legs bshad rtsis kyi ’od stong ’di shar bas / mi shes mun pa ma lus sel nges kyi / blo ldan gzhon nu’i tshogs rnams spro ba bskyed /*

[a] This should be *xia* 1 [= 1b]
[b] *khur* : I take this as the past from of *’khur* (to carry, shoulder, bear, etc.). I use the present form to render the word.
[c] *bsnams* is the past form of *snom*. I use the present form to render the word.

Oṃ Svasti! May all beings be permanently protected by Mañjuśrī, who carries dark blue braided hair [with] a golden-colored [body] and holds a sword of wisdom and the book of the *Prajñāpāramitā*, the divine being who clears away the darkness of ignorance and who grants the highest intelligence![778] By [bowing down our] crown of head, [we] serve the

[777] For the Tibetan appellation of Elhe Taifin Kangxi Emperor, Bde skyid is well known. See Tuttle (2011: 194-5. And see Karsten (unpublished: 5): Bde ’jag is given together with Bde skyid. In this colophon, Bde ldan is given as the Tibetan appellation of Elhe Taifin Kangxi. Since the Mongolian *Tngri-yin udq-a* from which the Tibetan *Rgya rtsis chen mo* was translated addresses him as ‘*manǰusiri degedü amuγulang qaγan*,’ which is reconstructed as ‘’Jam dbyangs gong ma bde ldan rgyal po’ in Tibetan and which appears later in this colophon, it is highly possible that the Tibetan appellation Bde ldan reflects that of the Mongolian original text *Tngri-yin udq-a.* It should be also noted that both the *Tngri-yin udq-a* and the *Rgya rtsis chen mo* were created by Mongolian lamas.

[778] In the Tibetan Buddhist iconography, Mañjuśrī holds a sword of wisdom in his right hand and the book of the *Prajñāpāramitā* on his left shoulder.

two feet of the Kangxi Emperor, Lord of Speech (S. vāgīśvara), Mañjuśrīkumāra[779], the one who showed the form of wheel-turning king (S. *cakravartinrāja*) for the excellence, virtuous actions, and lustrous qualities of all beings. Since this text, a thousand (immeasurable) rays of the well-put calculations, appeared from the spacious expanse of his vast intelligence, those young wise ones who will be certain to eliminate ignorance and darkness [by it] , with none remaining, will produce pleasure.

ces tshig gi spros pas rngun[a] *bsus nas skabs su cung zad gleng bar bya ba ni / spyir sangs rgyas shākya thub pa'i 'khrungs lo 'dir mkhas pa'i lugs mi 'dra ba mang du yod kyang / phug pa'i lugs la ston pa shākya thub pa de nyid 'dzam bu'i gling gi yul rgya gar gyi grong khyer ser skya'i lumbini'i tshal du lcags spre zla ba bzhi pa'i tshes bdun la sku bltams / dgung lo nyer dgu pa sa byi zla ba bzhi pa'i tshes bco lnga la rab tu byung / dgung lo so lnga pa shing rta zla ba bzhi pa'i tshes bco lnga la sangs rgyas / lo de ga'i zla ba drug pa'i tshes bzhi nas bzung wa ra ṇā si sogs su chos kyi 'khor lo bskor te gdul bya rnams phan bde'i lam la bkod / dgung lo gya gcig pa lcags 'brug zla ba gsum pa'i tshes bco lnga la dpal ldan 'bras spungs su sham bha la'i rgyal po zla ba bzang po la dus 'khor rtsa rgyud gsungs nas grub rtsis dar / lo de ga'i zla ba bzhi pa'i tshes bco lnga la rtswa mchog grong du mya ngan las 'da' ba'i tshul bstan pa nas bzung lo zhe bzhi pa shing pho byi lo'i hor zla bcu gcig pa'i tshes bco lnga'i sbrul gyi dus ri bo rtse lngar trikṣa*[b] *zhes pa'i shing gi lba ba las / rje btsun 'jam pa'i dbyangs sku mdog gser btso ma lta bu zhig sku bltams nas lha mi sogs /* [*shang* 2] *'khor rnam pa lngas bskor te bzhugs pa'i dus lha tshangs pas gser gyi 'khor lo rtsibs bcu pa dang / lha mo rnam rgyal mas lha'i me tog tsam pa ka phul te sems can gyi don du rtsis kyi rgyud gsung bar gsol ba btab pa la brten / 'jam dpal gyi sku gsung thugs yon tan 'phrin las kyi rgyud sogs rtsis sgo brgyad khri bzhi stong dang / gab rtse*[780] *sum brgya drug cu sogs gsungs shing lo brgya'i bar*

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[779] According to Lamotte, a bodhisattva on the tenth *bhūmi* such as Mañjuśrī has the titles of a young man (or prince) (S. *kumārabhūta*) and *ekajātipratibaddha* (Ch. *yisheng buchu* (一生補處); T. *skye ba gcig gis thogs pa*), the bodhisattva who is "bound to (only) one more birth" to attain buddhahood. For *kumāra*bhūta, Lamotte (1960: 13-4): "Le Bodhisattva de la dixième terre porte les titres d'*ekajātipratibaddha* et de *kumārabhūta*. ... L'epithete de *kumārabhūta*, en tibétain *gzhon nur gyur pa*, est presque synonyme: dans la dixième terre, le Bodhisattva reçoit l'onction (*abhiṣeka*) qui le consacre prince héritier (*kumāra*) du Roi de la Loi ... ." For *ekajātipratibaddha*, Lamotte points out that only a bodhisattva on the tenth *bhūmi* can obtain the *Śūraṃgamasamādhi*. See Lamotte (1960: 14): "c'est dans la dixième terre que le Bodhisattva entre en possession du *Śūraṃgamasamādhi* „concentration de la Marche héroïque" qu'il ne partage qu' avec les Buddha." For a detailed understanding of this term, read Sara Boin-Webb tr. (1998: 119 ff).

[780] No unanimous understanding for the term *gab rtse* (*gab tse*) has been reached. Tucci's rendering of the term is '*jiazi*' (甲子) referring to the Chinese sexagenary cycle. See Tucci (1949: 739, n. 31). Stein's rendering for the term is "oracle." See Stein, Mckeown Trans. (2010: 266, 271, n. 51). For the various understandings suggested by more scholars, see Tseng and Lin (2007: 169-207; especially 181, n. 39). Throughout the article, Tseng and Lin's suggestion is 'divination (Ch. *zhanbu* 占卜).' Here, I roughly render the term as 'Chinese divination.'

du sems can gyi don dpag tu med pa mdzad do zhes o ḍī ya na'i slob dpon chen po'i thang yig las bshad do / 'jam dbyangs 'khrungs pa'i lo nas rtsis pa'i[c] *lo lnga brgya dang drug cu tham pa song ba na / sham bha la'i rgyal po rigs ldan 'jam dpal grags pa la drang srong nyi ma'i shing rta la sogs pa'i skye bo du mas dus 'khor rtsa rgyud kyi don thams cad nyung ngur bsdus te bstan du gsol zhes gsol ba btab pa la brten dus 'khor bsdus rgyud gsungs nas byed rtsis dar bar grags so /*

[a] Read *sngun*
[b] Read *brikṣa.* *Brikṣa* is the Tibetan way of writing the Sanskrit term *vṛkṣa,* tree.
[c] Read *rtsi ba'i*

After having placed to the fore such an elaboration of words, as for speaking a little about the context: generally, though there are many dissimilarities among the scholarly traditions here regarding the year Śākyamuni was born, according to the *Phug* tradition he was born in the Lumbinī grove of an Indic town Kapilavastu, a place in *Jambudvīpa*, on the seventh day of the fourth month in the iron-monkey year (961 B.C.E.).[781] [He] was ordained at the age of 29 on the fifteenth day of the fourth month in the earth-mouse year (933 B.C.E.). [He] attained enlightenment at the age of 35 on the fifteenth day of the fourth month of the wood-horse year (927 B.C.E.). [He] turned the dharma wheel in Vārāṇasī, etc., from the fourth day of the sixth month of the same year, and established those to be disciplined on the path of happiness and well-being. After he proclaimed the *Kālacakramūlatantra* to the Śambhala king Sucandra (T. Zla ba bzang po) at the age of 81, on the fifteenth day of the third month of the iron-dragon year (881 B.C.E.) in lustrous Dhānyakaṭaka (T. 'Bras spungs), the *siddhānta* astronomy (T. *grub rtsis*) spread. At the snake time[782] of the fifteenth day of the eleventh Mongolian month of the wood-male-mouse year (837 B.C.E.), which was the forty-fourth year beginning from [his] achieving

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[781] According to the Sde srid (2002: 276-80), this tradition dates back to Lang tso ldang (*sic*. read *ldong*) yags who operated during the period of Khri srong lde'u btsan (8th c.) and his descendant Mi nyag Rgyal mtshan dpal bzang po, who received teachings from Khyung nag Shāka dar. Then, around the 15th century, the three famous Rgya mtsho-s appeared, followed by Dpal mgon 'phrin las pa (15th c.-16th c.), Padma Chos skyong, 'Chi med bde ba (16th c.), Ldum po Don 'grub dbang rgyal, et al. Dharmaśrī and the Sde srid are here said to be the zenith of the tradition. For more information, see also Yum pa's summary introduction to this book (*deb 'di'i ngo sprod mdor bsdus*) that is included in Grwa phug pa (2002: 1-4), and see above note 285.

[782] Snake time (Ch. *sishi* 巳時) is one of the 12 two hour periods of the day which falls from 9 to 11 (midmorning). For the Chinese context, see Chen (1983: 118-32), and Needham, Wang and de Solla Price (1986: 199-202). For the Tibetan context, see Henning (2007: 358), and above note 543.

nirvāṇa in the village of Kuśinagara, on the fifteenth day of the fourth month in the very year (881 B.C.E.), venerable Mañjughoṣa, one with a seemingly pure gold-colored body, was born from a burl of the tree named *vṛkṣa* in Wutaishan. Then, when he was surrounded by a five-fold assembly including celestial and human beings, Brahma offered him a golden wheel with ten spokes and the goddess Vijayā offered *campaka*[783] and they pleaded for him to speak the calculational tantra for the benefit of sentient beings. On that basis, he stated the eighty-four thousand doorways to calculations and the three hundred and sixty kinds of Chinese divination, which are the tantra-s, etc. of Mañjuśrī's body, speech, mind, merit, and buddha activity, and brought immeasurable benefit for sentient beings up to one hundred years, as it is stated in the *Thang yig*[784] of the great teacher Padmasambhava from Oḍḍiyāna.[785] It is known that when a full five hundred and sixty years had elapsed (277 B.C.E.), as calculated from Mañjughoṣa's year of birth, having been petitioned by many people including the sage (S. *ṛṣi*) Sūryaratha (T. Nyi ma'i shing rta) and others to the Śambhala king Kalki Mañjuśrī Yaśas (T. Rigs ldan 'Jam dpal grags pa),[786] saying "please summarize all the meanings of the *Kālacakramūlatantra* and teach [it]", he spoke the *Laghukālacakra,* and then the *karaṇa* astronomy (T. *byed rtsis*) spread.

da ni rtsis kyi bstan bcos 'di nyid ji ltar byung ba'i rgyu mtshan ni gong gi 'jam dbyangs 'khrungs pa'i lo nas rtsis pa'i[a] *lo nyis stong dang bzhi brgya dgu cu go gnyis song ba na / 'chi med dbang po'i grong khyer sa la 'phos pa lta bu rgyal khab chen po pe cing zhes bya bar / 'jam dpal gzhon nur gyur pa de nyid mi'i dbang po'i tshul bzung nas phyogs ris med pa'i 'gro ba mtha' dag phan bde'i lam la 'god par dgongs te stobs kyi 'khor los bsgyur ba shun ji rgyal po'i*[787] *sras su shing rta zla ba*

[783] Many books of Tibetan *Materia Medica* (T. *'khrungs dpe*) can be used to identify this plant. For example, Pasang Yonten's (1998: 194) glossary reads as follows for *campaka:* "Oroxylum indicum vent. It is a white smooth and flat seed found in large numbers inside a long, flat pod which is about the size of an arrow."

[784] The information is found in Toussaint (1933: 152-8). For its English Translation, see Douglas (1978: 224-30). For a brief summary of the part (chapter 35), see Tucci (1949: 377). Also for relevant passages, see the *Blon po bka'i thang yig* in the *Bka' thang sde lnga*. Beijing: mi rigs dpe skrun khang (1986: 497-8). It was studied by Schuh (2004: 1-23).

[785] Many different spellings exist: *Oḍiyāna*, Uḍḍiyāṇa, Uḍḍiyāna, Uḍiyāna, Uḍyāna, Udyāna, etc.

[786] He is sometimes wrongly sanskritized as Mañjuśrīkīrti; see Newman (1987: 156-7). For the history of Śambhala kings, see Newman (1985: 51-90).

[787] For the appellation of Eyeber ǰasaγči Shunzhi Emperor in Tibetan, see Tuttle (2011: 194). Also see Karsten

gsum pa'i tshes bco brgyad la bkra shis shing[b] *ngo mtshar ba'i ltas du ma dang bcas sku bltams / lcags glang hor zla dang por 'jig rten gyi mes po tshangs pas gnam gyi sgo phye nas gser 'brug gis mngon par bteg pa'i mang pos bkur ba'i rin po che'i khri la bsod nams gser gyi 'khor los bsgyur ba 'jam dbyangs gong ma bde ldan rgyal po chen po zhes bya bar dbang bskur te lha mi 'gro ba mtha' dag gi spyi bo'i cod pan du* [*xia* 2] *zhabs sen bkod nas / phyogs kun las rnam par rgyal ba'i ru mtshon srid rtse'i bar du bsgreng zhing / khrims kyi gdugs dkar po gcig gis gnam pa'i*[c] *khyon thams cad yongs su gang bar 'khor ba'i grib bsil la 'gro ba mtha' dag bde skyid*[788] *kyi dpal la bkod / sangs rgyas kyi bstan pa rin po che phyogs brgyar spel ba'i phyir gtsug lag khang dang sku gsung thugs kyi rten bzheng ba dang / dge 'dun gyi sde 'dzugs pa dang bsnyen bkur ba sogs bstan pa la sri zhu mtha' klas pa mdzad / rtsis kyi gzhung lugs mtha' dag la yang zhib tu dpyad nas nyams pa rnams bsos / nor ba rnams bcos / ma tshang ba rnams tshang bar mdzad / gsar du bsnon dgos pa rnams rang nyid kyis bsnan te go bde ba dang rtogs sla ba'i phyir du rtsis kyi snying po rnams phyogs gcig tu bsdebs te rgya yig tu bkod nas rgya nag chen po'i yul khams thams cad du dar zhing rgyas par mdzad cing / de nas drung na 'khod pa'i khyi ya bkra shis la sog skad du bsgyur zhig ces pa'i bka' lung gnang ba la brten rgya sog gi lo chen rnams kyis sog skad du bsgyur ba yin no /*

[a] Read *rtsi ba'i*
[b] Read *dang*
[c] Read *gyi* or *gnam sa'i khyon*

Now, as for the process of how this astronomical text came into being: when twenty-four hundred and ninety-two years had passed, as calculated from Mañjughoṣa's year of birth above, the *Mañjuśrīkumārabhūta,* having appeared in the form of a human ruler and intending to establish the path without partiality for the happiness and well-being of all beings, was born as a son of the Shunzhi (Ch. 順治. r. 1644-1661) Emperor, a powerful wheel-turning king, with auspiciousness and many miraculous signs, on the eighteenth day of the third month of the wood-horse year (May 4th 1654 C.E.) in the great capital called Beijing, a city comparable to the immortal king's city shifted to the earth. In the first Mongolian month of the iron-ox year, (1661 C.E.) after Brahma, the worldly forefather, had opened the gate of the sky, he (Kangxi Emperor) was empowered (S. *abhiṣeka)* as the one called the golden *cakravartin* of merit,[789] the Mañjughoṣa (Mañjuśrī)

(unpublished: 4).

788 It literally means happiness and well-being. But, it is highly possible here that it denotes Elhe Taifin Kangxi Emperor. See above note 359.

789 For the notion of golden *cakravartin* in the Tibetan Buddhist cosmology, see Walter (2009: 289-90). He cites Inagaki's article in which the following interpretation on golden *cakravartin* is found: "A golden

Emperor the Great King with Happiness, on the precious throne supported by a golden dragon. He was honored by the multitudes, and having placed his toenails on the crown of the tops of the heads of all the gods, humans, and sentient beings, he placed all sentient beings under the shade of *saṃsāra* in [the state of] the luster of Emperor Kangxi, to the extent that the all-victorious banners from all directions were raised up to the summit of the world and the white parasol (S. *sitātapatrā)* of law (S. *dharma*) completely filled the entirety of the sky [or: "the entirety of heaven and earth" (see note c above)].[790] In order to spread the precious teaching of the Buddha in one hundred directions (every direction), he pays limitless respect to the teaching, such as the construction of temples and statues, scriptures and *stūpa*s, and the establishment and worship of the divisions of buddhist communities, etc. Having examined in depth all the scriptural traditions of astronomy, he restored what was damaged, corrected what was wrong, and made the incomplete complete. He himself added what should be newly added, and in order [for them] to be easily understood and easily known, having united as one the quintessence of calculations, and written [it] in Chinese, he spread and expanded [it] to places all over great China.[791] Then, based upon the command given to his attendant Kiy-a Raši,[792] and others, saying "translate [it] into Mongolian," the great Chinese and Mongolian translators translated [it] into Mongolian.

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cakravartin is the noblest and the most powerful of all four kinds of *cakravartin*s, or ideal kings in India, and is said to reign in the four continents. The other three are silver, copper, iron *cakravartin*s." For the citation, see Inagaki Hisao, "Kūkai's Sokushin jōbutsu gi," *Asia Major* 17, no. 2 (1972: 196, n. 4).

[790] For religious implication of *sitātapatra* in the Qing dynasty, see Sørensen (2011: 112). For its flourishing in the Yuan dynasty, see Cleaves (1957: 455, n. 124). For a textual study based upon different Mongolian *sitātapatra* (M. *čaγan šikürtei*) texts, see Sárközi (2007). For a brief review of Western scholarship on *sitātapatra*, see Sárközi (2007: 231, n. 2).

[791] For a general history of Qing astronomical systems including the *Xiyang xinfa lishu* in the above context, Shi (2008) is recommendable.

[792] For Raši, see above note 762. For phonetic relationship between *bkra shis* and *raši*, see Lessing (1960: 236): "*dasi* and *rasi* are given for the Mongolian equivalents of Tibetan *bkra shis*." Also see Kara as translated in Krueger (2005: 134): "In the later, non-Amdo-style, phonetic transcriptions two Mongolian ways to read Tibetan words are reflected, for instance, the name Bkra shis 'fortune, happiness', is transcribed in the form Daši among the Khalkhas, Buryats and some North-Eastern (for instance, Khorchin) Mongols but Raši among the Oirats and the Southern Mongols (Ordos, Chahar, Tümet, Kharchin)."

de nas bod skad du ji ltar bsgyur ba ni / 'jam dbyangs gong ma chen pos rang nyid kyi slob ma lugs 'di la mkhas par sbyangs pa'i dge slong ngag dbang blo bzang dang / dge slong bstan pa rgyal mtshan gnyis gser yig tu mngags te rje btsun dam pa hu thog thu la sog skad du bsgyur ba'i rtsis dpe rnams gnang nas bod skad du bsgyur zhig ces bka' stsal ba la brten skyes chen dam pa de nyid kyis gtso mdzad de / hu bil la gan rab 'byams pa gun paṇḍi ta / er te ni bhi lig thu rnams kyis bsgyur zhing / yig mkhan grags pa sogs yig rigs[a] *pa du ma dang bcas glegs bam du bcos te gong ma'i phyag tu 'bul bar gnang / de skabs gong ma chen po'i thugs rje'i grib bsil la /* [*shang* 3] *nye bar 'khod pa'i pe cing na gnas pa'i thub pa'i ring lugs 'dzin khrul gyi tha shal ba bdag cag rnams la zhu dag legs par gyis la spar du brkos shig ces pa'i bka' lung dri ma med pa spyi bor phebs pa la brten pe cing gi bla ma dge 'dun rnams kyi khrims 'dzin pa ja sag gi gtso bo ngag dbang dpal 'byor hu thog thu / ja sag gi bla ma sman rams pa kun bzang / ja sag gi bla ma bstan pa dge slong / ja sag gi bla ma bstan 'dzin dge slong / tā bla ma rab 'byams pa tshul khrims bzang po / tā bla ma rab 'byams pa grags pa blo bzang / bhas so lang dge slong / bsod nams chos rje hu bil la gan bcas pas brtson pa chen pos sog skad bod skad gnyis legs par bsdur / go ma bde ba rnams rgya'i yig cha dang bstun / gnam gyi bkod pa dang tshad 'jal ba'i ri mo 'dri*[b] *dgos rnams rgya rtsis pa pō shi le'u yus sis bris shing / yig mkhan dge slong ngag dbang chos* x[c] *sogs yig rigs*[d] *pa du ma dang bcas blo nus la dpags pa'i zhu dag legs par byas nas tā'i ching bde ldan lo nga bzhi pa shing mo lugs lor spar du bkod pa yin no / manga lam /*

[a] Read *rig*
[b] Read *'bri*
[c] illegible
[d] Read *rig*

After that, as for how it was translated into Tibetan, the Mañjughoṣa Great Emperor dispatched as envoys his students, the *bhikṣus* Ngag dbang blo bzang and Bstan pa rgyal mtshan, who had become learned in this tradition, and gave the calculational volumes translated into Mongolian to the J̌ibǰundamba Qutuɣtu (Rje btsun Dam pa Blo bzang bstan pa'i rgyal mtshan, 1635-1723), et al. According to the command he gave, saying "translate them into Tibetan," headed by the holy great master (Rje btsun Dam pa), [he] and the Qubilɣan[793] Rabǰamba / Rabǰimba Güng[794] Bandida (T. Hu bil la gan Rab 'byams pa Gun Paṇḍita) and Erdeni Biligtü (T. Er te ni Bhi lig thu) translated [them]. Many persons who knew reading and writing, including the skilled writer Grags pa, made it into a book, and

[793] Precisely, *qubilɣan* (M.) is *sprul pa* in Tibetan and *qubilɣan-u bey-e* (M.) is *sprul pa'i sku* (*sprul sku*) in Tibetan. But, *qubilɣan* ('*Hu bil la gan*' in Tibetan in this colophon) simply denotes *sprul sku.*

[794] *Güng* is 'duke' which derives from Chinese *gong* (公); meanwhile *gün* means 'deep' in Mongolian. The former makes more sense than the latter for the Tibetan *gun*.

it was offered into the hands of the Emperor. At that time, relying upon the stainless command which came upon the crowns of [our heads, saying "proofread well and carve [it] into printing blocks", we, the mistaken, inferior holders of Śākyamuni's tradition, who live in Beijing under the shade of the Great Emperor's compassion, Aγwangbalǰuur Qutuγtu (T. Ngag dbang dpal 'byor Hu thog thu), the chief administrative [lama] (T. ja sag gi gtso bo) and the holder of law (dharma) of the lamas and buddhist communities in Beijing, and the administrative lama Manramba Güng(γa)sang(bu) (T. ja sag gi bla ma Sman rams pa Kun dga' bzang po)[795], the administrative lama Damba Gelüng (T. ja sag gi bla ma Bstan pa Dge slong), the administrative lama Danǰin Gelüng (T. ja sag gi bla ma Bstan 'dzin Dge slong), the Da lam-a Rabǰamba / Rabǰimba Čülrimsangbu / Čültümsangbu (T. Tā bla ma Rab 'byams pa Tshul khrims bzang po)[796], the Da lam-a Rabǰamba Raγbalubsang (T. Tā bla ma Rab 'byams pa Grags pa blo bzang), Bayasqulang[797] Gelüng, and Sudnamčorǰi / Sudnamčoyiǰi *Qubilγan* (T. Bsod nams Chos rje Hu bil la gan (T. *sprul*

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[795] M. *ǰasaγ-un lam-a* > T. *ja sag gi bla ma*, Ch. *zhasake lama* 扎薩克喇嘛. M. *manramba* < T. *sman rams pa.* Güng(γa)sang(bu) < T. Kun (dga') bzang (po).

[796] M. *da lam-a* > T. *tā bla ma*, Ch. *da lama* 達喇嘛. *rabǰamba* /*rabǰimba* < *T. rab 'byams pa.* M. Čülrimsangbu / Čültümsangbu < T. Tshul khrims bzang po.

[797] I tentatively take *bhas so lang* as the Mongolian *bayasqulang* meaning rejoicing, gladness, happiness, etc.

sku)), compared the Mongolian and Tibetan thoroughly and with great enthusiasm.[798] [We] have compared all that was not easy to understand with the Chinese text. The Chinese astronomer-instructor (T. *pō shi* < Ch. *boshi* 博士) Le'u yus si[799] wrote (drew) all of the sky-maps and the measured figures which needed to be put in writing,[800] and many persons who know reading and writing, such as the skilled reader and writer *bhikṣu* Ngag dbang chos x (illegible) and others, proofread [it] well according to their intellectual abilities, and then carved [it] in the wood-female-sheep year, the Kangxi fifty-fourth year (1715 C.E.-1716 C.E.) of the Great Qing. *Maṃgalam*!

[798] The titles listed in this colophon are found in *Qinding lifanbu zeli* (欽定理藩部則例) issued in 1908. — The history and lineage of the text is complex. And note that there existed relevant articles and clauses for the organization of Mongolian lamas and monasteries in Qing law books from the earlier Qing period. — There also exist a number of modern works enabling us to identify these titles. Some notable examples include Brunnert and Gagelstrom (1911: 477); Yu (1992: 491-2); Zhang2 (2002: vol. 2, 615 ff); and Luo (2005: 564). To give a brief explanation of these titles as ranked from top to bottom: (1) *zhangyin zhasake lama* 掌印扎薩克喇嘛. *Zhasake d*erives from Mongolian *ǰasaγ* meaning 'administration.' See Lessing (1960: 1039-40), Norman (1978: 156): *jasak* 'chief of a Mongol banner', (2) *fu zhangyin zhasake lama* (副掌印扎薩克喇嘛), (3) *zhasake lama* (扎薩克喇嘛), (4) *dalama* (達喇嘛), (5) *fudalama* (副達喇嘛), (6) *sula lama* (蘇拉喇嘛): leisured lama, lama without a fixed position. The latter derives from the Mongolian *sula* meaning loose, free, unoccupied. See Lessing (1960: 736), Norman (1978: 252): *sula*: 'loose, idle, unemployed in an official capacity,' (7) *demuqi* (德木齊) (< M. *demči*). Lessing (1960: 250): 'business manager in a monastary,' (8) *gesiqui* (格斯貴) (< M. *gebküi*, *geskϋi* < T. *dge skos*). See Lessing (1960: 372): 'master of a discipline, proctor in a temple.'). Chief *ǰasaγ-un lam-a*, my rendering for *ja sag gi gtso bo* in this colophon, seems to indicate the first-ranked *zhangyin zhasake lama* ((1) in the above) or the second-ranked *fu zhangyin zhasake lama* ((2) in the above). More research is needed to identify their Mongolian titles, but it is beyond the present concern. The identification of the titles and activities of the Mongolian lamas listed in this colophon is regrettably not possible at the moment. We have no accumulated research and knowledge for them.

[799] More research is needed to identify this Chinese astronomer.

[800] There are two possibilities for *ri mo*: first, *ri mo* is 'figures' in astronomical text. Secondly, *ri mo* is 'picture', 'diagram,' etc. The reason why I side with the former is that 'the pictures that have been measured out' may not make sense. Moreover, they possibly had astronomical knowledge.

APPENDIX IV.

EIGHTEENTH CENTURY MONGOLIAN LAMAS' *KĀLACAKRA* KNOWLEDGE AND THE TRANSLATION OF THE *RGYA RTSIS CHEN MO*[801]

The preface of the *Tngri-yin udq-a* (see Appendix II, pp. 344-6) shows that professional scientists and astonomers existed at the Qing court among the Mongolian translators. In contrast, the printer's colophon in the *Rgya rtsis chen mo* (See Appendix III, especially 353-5) shows that the Mongolian lamas in Beijing and Ulaγanbaγatur were ordered to translate the *Tngri-yin udq-a* into the *Rgya rtsis chen mo* based upon knowledge of *bstan rtsis* / *Dus 'khor* (*Kālacakra*), and, as such, the overall contents in the colophon are religious.

From such observations, I seek to answer the following questions with a focus on the formation and development of astronomical terms and concepts within the broader framework of eighteenth century Mongolian lamas' knowledge of the *Kālacakra* (*Čaγ-un kürdün*): what knowledge of the *Čaγ-un kürdün* (*Kālacakra*) did the translators of the *Tngri-yin udq-a* have in terms of astronomical research in general and eclipse calculations in particular? Is there any sign that knowledge of the *Čaγ-un kürdün* was used to translate the *Tngri-yin udq-a* filled with modern knowledge?

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[801] This appendix is a brief sketch of knowledge regarding the Mongolian lamas in the 18th century. Because I used limited Mongolian sources to sketch the topic, my arguments will be able to be reinforced with more evidence and specifications. I hope that this appendix will be read in concordance with chapters 3 and 4.

For the first question, I briefly sketch the following issues: 1) the use of the *Čaγ-un kürdün* terms in Mongolian, 2) mistranslations, 3) the relationship between the *Čaγ-un kürdün* and *odun-u ǰiruqai* (*skar rtsis*). Firstly, the *Čaγ-un kürdün* terminology was established at a relatively early time. To illuminate this fact, it is important to consider the Mongolian *Laghukālacakra*, which is included in the so-called *Altan Γanǰuur* (completed during the years 1628-1629).[802] It has been publicized in a modern format, together with that in the *Singqun Γanǰuur*, was created during the period of the Elhe taifin Kangxi Emperor (1718-1720).[803] Given the translations, the technical astronomical vocabularies must have been already well-established when the *Altan Γanǰuur* was created. The terms and concepts of the *Laghukālacakra* in the *Singqun Γanǰuur* generally follow those of the *Laghukālacakra* in the *Altan Γanǰuur*.

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[802] The *Altan Γanǰuur* is known to be one of the earliest translation of the Tibetan *Bka' 'gyur* into Mongolian. It has been reported by modern Mongolian scholars that some included texts remain in Öbör mongγol-un neigem-ün sinjilekü uqaγan *akademi-yin* nom-un sang (Ch. Neimenggu shehui kexueyuan tushuguan 内蒙古社会科学院图书馆) in Kökeqota, Inner Mongolia, notably the *Laghukālacakra* (M. *Angqan-u degedü burqan-ača γarγaγsan čoγ-tu čaγ-un kürdün neretü dandris-un qaγan*). About the *Altan Γanǰuur*, Nata's *Altan erike* (c. 1817) (1991: 110) states that it is composed of "one hundred three *kelemli*" (*ǰaγun arban γurban kelemli*). — The strange term *kelemli* appears in Čidaltu (2005: *passim*) in the form of *kalmali* / *gelmeli*. Nearly no Mongolian dictionaries include this term except for Rikugunshō (1933: 1599) and Lessing (1960: 375): "*gelmeli:* tome, volume, division, chapter." My suggestion for it is "wooden box." More research is clearly needed. — In addition, Nata (1991: 110-1) conveys how the *Altan Γanǰuur* was created: a man named Taiǰi Ling baras (*sic*. read *bars*) (B: Gilinarbini (?), C: Dgiligsrebins (?). Regarding the differences among the four versions, see above note 762.). According to the editor Čorǰi, Dge legs rab rgyas was written in the edition C, He also had a manuscript of the *Γanǰuur* and it is not known whether it was a Tibetan or Mongolian version. Biligtü Sečen ombu (onbo) (<- bingtü (B: biligtü) Sečen umku (*sic*. read *ombu*/ *onbo*)) is known to have requested it and then the blockprint of the *Altan Γanǰuur* was completed. For Sečen ombu, see Kollmar-Paulenz (2002: 177-87, 180-2).

[803] See the *Γanǰuur*, vol. 1 (1996: 25a-164a). The appendix in this volume clearly presents the different entries between the *Altan Γanǰuur* and the *Singqun Γanǰuur*. It is the only version which presents the Mongolian *Laghukālacakra* in the *Altan Γanǰuur*. The issue as to what is the Tibetan original *Bka' 'gyur* of the *Altan Γanǰuur* and the *Singqun Γanǰuur* appears difficult to solve.

Likewise, the astronomical section *uralaqu uqaɣan–u ɣoul* in the later text *Merged ɣarqu-yin oron* (1742) basically reflects the well-established astronomical terminology and concepts found in a period of the early 17th century at the latest. Even if the *Merged ɣarqu-yin oron* was designed to clarify the terminologies for the creation of the *Danǰuur*,[804] the *Danǰuur* translators could not change the renderings of the *Altan Ɣanǰuur / Singqun Ɣanǰuur* by using it. For example, a synonym of *gdengs can* meaning eight, is given as *erbeger-tü*[805] in the *Merged ɣarqu-yin oron*, but the following rare word was already given in the *Altan / Singqun Ɣanǰuur* translations that were maintained in the Mongolian *Vimalaprabhā*: *tongloiɣsan terigü-tü.*

Table 52.

Tibetan *Laghukālacakra* I. 27	Mongolian *Laghukālacakra* I. 27
lag pa gdengs can zla ba[806] = 182.	*ɣar tongloiɣsan*[807] *terigütü saran* .[808]

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[804] For the reason why the Tibetan *Dag yig mkhas pa'i byung gnas* was created, see Seyfort Ruegg (1974: 257-8).

[805] Lcang skya III et al. (2002: 1208). For *erbeger,* see Ishihama and Fukuda (1989: 337-8, 397) and Sárközi and Szerb (1995: 244, 561): "head / expanded hood of a snake."

[806] *P. Bka' 'gyur rgyud, ka,* 26a. Also see Henning (2007: 221).

[807] *Sumatiratna* (1959: vol. 1, 1059): "*tonglaɣar*" for "*dgengs ka*" can be observed. I do not know the precise meaning, but it seems to be related to the above "*tongloiɣsan.*"

[808] *Ɣanǰuur*, vol. 1 (1996: 28b). To check the differences between the *Altan Ɣanǰuur* and the *Singqun Ɣanǰuur*, see appendix, p. 4. There is no difference in this case.

Table 53.

Tibetan *Vimalaprabhā* (*Dri med 'od*) I. 27	Mongolian *Vimalaprabhā* (*Gkir ügei gerel-tü*) I. 27
lag pa gdengs can zla ba … lag pa gdengs can zla ba.[809]	*γar čo(u)ngnoimal-tü*[810] *saran. … γar tongloiγsan saran.*[811]

It looks difficult to find the etimology of specific words. The Mongolian translations may not be based upon a complete understanding of the terms. The Mongolian *Laghukālacakra* I. 27 presents "*tongloiγsan terigütü*" (lit. with head), but the Mongolian *Vimalaprabhā* I. 27 just presents "*tongloiγsan*" without *terigütü*, and added a rare word "*čo(u)ngnoimal-tü.*" More research is needed, but it can be speculated that "*čo(u)ngnoimal-tü*" may be an archaic word from Mongolian Buddhist texts. My point is that the astronomical terms and concepts in the *Čaγ-un kürdün,* that were established in the early 17th century at the latest by the completion of the Mongolian *Laghukālacakra*, and in the *Altan Γanǰuur* have been sources for later period translations of and research into the *Čaγ-un kürdün* corpus.

Secondly, mistranslations are seen in the *Gkir ügei gerel-tü*, which was first created in the 18th century as a part of the *Danǰuur*. The translation is deft, but it sometimes does

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809 *P. Bstan 'gyur, rgyud 'grel*, *ka*, 77b. See also Henning (2007: 222).

810 *Sumatiratna* (1959: vol. 1, 1059): "*čo(u)ngnoimal*" for "*dgengs ka*" and "*čo(u)ngnoimal-tü*" for "*dgengs ka can*" / "*gdengs can*" are given.

811 *Danǰuur*, vol. 2 (2007: 93b).

not closely shadow the original Tibetan text (possibly the *P. Bstan 'gyur*).[812] The following simple errors are intriguing:

Table 54.

Dri med 'od I. 30	*Gkir ügei gerel-tü* I. 30
mi bdag ces pa ni drug bcu ste … .[813]	*kümün-ü eǰen kemekü inü arban ǰirγuγan buyu … .*[814]

This is understandable because *mi bdag* / *kümün-ü eǰen* equals 16. The Tibetan is read as 16, not 60, even if 60 was written.[815] The Mongolian rendering just presented 16 without applying the *bhūtasaṃkhyā* system. However, things are not always so simple, as shown below.

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[812] It was completed in 1749 during the reign of Abkai wehiyehe Qianlong Emperor. The Tibetan original appears to be the *P. Bstan 'gyur* (1724); see Dharmatāla (1987: 388-9): "That edition was based on the Tibetan Tengyur (edited by) Miwang Sangye Gyatsho as the long-life offering to the All-Knowing Royal One (= the Great Fifth Dalai lama). … Besides the standard contents, (the Mongolian Tengyur) included some new translations. Its catalogue, however, follows the one compiled by the All-Seeing Great Fifth (Dalai lama)." For the Tibetan *Bstan 'gyur* (1688) that Dharmatāla mentions, see Vostrikov (1970: 213-5), Deleanu (2006: 85-6), van der Kuijp (2012: intro 1), etc.. Rintchen (1964-74: 11-3) also maintains that the Mongolian *Danǰuur* is based upon *P.* Tibetan *Bstan 'gyur*. However, the issue appears complicated in the case of the *Gkir ügei gerel-tü*. See below note 820. I am doubtful about the premise that each and every text in the Mongolian *Danǰuur* was created from a single source. Individual text may vary significantly.

[813] *P. Bstan 'gyur, rgyud 'grel*, *ka*, 79a-79b. For the translation and explanation of it, see Henning (2007: 229, 232).

[814] *Danǰuur*, vol. 2 (2007: 95b).

[815] See the *bhūtasaṃkhyā* system in above pp. 186-7.

Table 55.

Dri med 'od I. 31	*Gkir ügei gerel-tü* I. 31
rkang pa bcu pa dang chu gter zhes pa cha'i lhag ma rkang pa bzhi pa mthong na nyi shur gcig gis dman par 'gyur ro / .[816]	*köl arban ba usun-u sang kemekü qubi-yin ülegsen köl dörben-i üǰebesü γučin-dur nigen-iyer simedgekü boluyu.*[817]

In the *Dri med 'od*, 20 (*nyi shu*) is given. In the *Gkir ügei gerel-tü*, 30 (*γučin*) is given. This is a problem. Again, in the *Dri med 'od* I. 32,

Table 56.

Dri med 'od I. 32	*Gkir ügei gerel-tü* I. 32
... bzhi pa la bzhi pa'i gnas na gnas pa bzhi dang lhan cig nyi shur gcig gis dman pa'o / lnga pa la lnga pa'i gnas na gnas pa gsum dang lhan cig nyi shu rtsa gnyis so / .[818]	*... dütüger-tür dütüger-ün oron-a aγsan dütüger lüge qamtu γučin nigen-iyer doruitaγulqu bolai. tabdaγar-tur tabdaγar-un oron-a aγsan γurban luγ-a qamtu γučin qoyar bolai.*[819]

This issue also arises in the *Dri med 'od*: 20 and 22, and in the *Gkir ügei gerel-tü*: 30 and 32. It is unclear how to make sense of this. It is not likely that the translators made intentional corrections for accurate *gza'* value in Mongolia, given the fact that the *Gkir ügei gerel-tü* is a literal translation of the *Dri med 'od*. Then, are these simple mistakes which occurred in the course of the translation? Or, did the translators use other Tibetan editions or sources?

[816] *P. Bstan 'gyur, rgyud 'grel*, *ka*, 80a. For the translation and explanation of this, see Henning (2007: 233, 235).

[817] *Danǰuur*, vol. 2 (2007: 96b).

[818] *P. Bstan 'gyur, rgyud 'grel*, *ka*, 80b. For the translation and explanation of this, see Henning (2007: 237).

[819] *Danǰuur*, vol. 2 (2007: 97b).

What other possibilities are there to account for the mistranslations?[820] At any rate, it is also true that the *Gkir ügei gerel-tü* was created through research into well-established terminology from the past.

Thirdly, let us ponder the relationship between the translations of the Mongolian *Čaγ-un kürdün* texts and *odun-u ǰiruqai* in terms of technical vocabularies and concepts. Little is known about the beginning of the *odun-u ǰiruqai* in Mongolia, and especially about eclipse calculations. Fortunately, in the 18th century, Mergen gegen Lobsangdambiǰalsan (< T. Blo bzang bstan pa'i rgyal mtshan. 1717-1766) could be used. At least three (one comparatively longer, two shorter) *ǰiruqai* (*rtsis*) texts are included in the fourth volume

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[820] The colophon of the first two chapters of the Mongolian *Vimalaprabhā* in the *Danǰuur*, vol. 2 (2007: 275a-275b) [= Rintchen (1964-1974: 21) = "*Mongγol γanǰuur danǰuur-un γarcaγ*"-un nayiraγulqu ǰöblel (2002: 174-5)], which shows that they were translated by the great translator Bilig-ün Dalai (? ~ ?) known as Urad Güüsi Bilig-ün dalai Sirabǰamsu (< T. Shes rab rgya mtsho)) with the help of Urad Güüsi Erdem-ün gerel (? ~ ?), conveys the following information regarding how they were translated: "Bilig-ün Dalai, dā (tā) lama at Jingzhusi (淨住寺 > M. J̌ing ǰu sē keid / Ariγun saγurin keid), translated the first chapter into this chapter (= the second chapter) from Tibetan to Mongolian by comparing and contrasting two sūtra-s, i.e. a xylograph and a manuscript, with the Tibetan and Mongolian *Kālacakratantra* (my suggestion for this is the *Laghukālacakra.*). Also, once again, the translators Bilig-ün Dalai and Urad Güüsi Erdem-ün gerel proofread, edited, and *x* (illegible) into [this] sūtra by comparing and contrasting the very one with the *Great Commentary* written by Mkhas grub and Mongolian *rtsis* texts (= my suggesion for *mongγol ǰiruqai-yin sudur-uud.* I am not sure what they might be.)." (*... čaγ-un kürdün-ü tailburi egüni ekin-eče ene bülüg kürtele ǰing ǰu sē keid-ün terigün blam-a bilig-ün dalai darumal bičimel qoyar sudur-i töbed mongγol čaγ-un kürdün-ü dandir-a luγ-a tokiyalduγul-un* (*sic*. read *tokiyalduγulun.* This form is strange. My suggestion is "by –ing.") *töbed-ün kelen-eče mongγolčilan orčiγulbai. ǰiči basa dabtan mün kü orčiγuluγči bilig-ün dalai kiged urad güüsi erdem-ün gerel qoγaγula qairu(o)b* (maybe *qaido(u)b*) *čorǰi-yin ǰokiyaγsan yeke tailburi kiged mongγol ǰiruqai-yin sudur-uud luγ-a tokiyalduγulun ariγudqaǰu nairaγuluγad sudur-tur x* (illegible)). This colophon informs us that Bilig-ün Dalai referred to different versions of Tibetan and Mongolian texts, specifically Mkhas grub's *Great commentary* and Mongolian astronomical texts, in order to create the translation of the Mongolian *Vimalaprabhā*. This may be realted to the strange change of the values. Let me leave the issue open to future research. With regards to the life of Bilig-ün dalai, little is known, but Heissig (1954: *passim*, especially 87-8) and Taube (1978: 172, n. 14) have presented information of his titles in Beijing. According to the *Merged γarqu-yin oron,* he was a "vice professor (M. *ded baγsi*) at *Tangγud bičig-ün surγaγuli* (School of Tibetan Language) and *dā* (*tā*) *bla ma* (*terigün lama*) at Jingzhusi."; see Lcang skya III et al. (1982: 20): *tangγud bičig-ün surγaγuli-yin ded baγsi büged ǰing ǰu ši-yin da blam-a* sirabǰamsu, and Lcang skya III et al. (2002: 1422): *bod kyi bslab grwa'i rim pa gnyis pa'i slob dpon cing ju ji'i tā bla ma dge slong shes rab rgya mtsho.*

of his *gsung 'bum*, *Včir-dhara mergen diyanči blam-a-yin gegen-ü 'bum ǰarlig*:[821] 1) *Tegüs čoγtu čaγ-un kürdün-ü ǰiruqai-yin γar-dur abqui-yi*[822] *toda üǰegülügsen naran gerel* (simply *Naran gerel*)[823], 2) *Γaraγ kiged naran-u türgen ǰiruqai-yin γarun abulγ-a*[824], 3) *Üiles-ün ǰiruqai-yin γarun abulγa-yin temdeg*.[825] Basically, the writings follow the typical order and sequence seen in the Tibetan *skar rtsis* texts.

Let me first look into the third text. It describes *üiles-ün ǰiruqai* (T. *byed rtsis*), whose epoch is 1747 (M. 1747 [= *küsel-tü* (13) *brabadau-a-yin* (< S. *prabhava*) *nügčigsen*

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[821] His collected works were published in Beijing after his death and during the years 1780 ~ 1783. The carving quality is bad. Many typographical errors exist, especially numbers that were badly carved. Chinese carvers who do not know Tibetan and Mongolian must have carved them. The sequence of the volumes are given according to the *Qianziwen* (千字文): the first volume: *tian* (天), the second volume: *di* (地), the third volume: *yuan* (元), and the fourth volume: *huang* (黄). For information on his *gsung 'bum*, see Heissig (1954: 151): "... in vier Bänden 130 Werke. ... Die 130 Werken sind nicht chronologisch, sondern ihrem Thema nach angeordnet. Viele von ihnen waren schon 1774 in den Chos spyod des Öljei badaraγsan süme veröffentlich worden." For the titles of the individual texts, see Uspensky, Inoue, and Nakami (2001: 113-45). Also see Humphrey and Ujeed Hürelbaatar (2013: *passim*).

[822] The *γar-dur abqui* is a Mongolian rendering of *lag len.*

[823] A rough division in the text ranging from *huang shang yi ri* (黄上一日) 49 ~ *huang xia yi ri* (黄下一日) 81 is as follows: the folios *huang xia yi ri* 49 ~ *huang shang yi ri* 50 are introduction (T. *sngon 'gro*) and things such as synonyms for numbers (the *bhūtasaṃkhyā* system) are given. *Huang xia yi ri* 50: 1 ~ *huang shang yi ri* 58:25 depicts the *bstan rtsis*, including the Mongolian *qaγans*. *Huang shang yi ri* 58:26 ~ *Huang xia yi ri* 61:24 describe *grub rtsis* (M. *sidi-yin ǰiruqai*). *Huang xia yi ri* 61:25 ~ *huang xia yi ri* 62:18 are *byed rtsis* (M. *üiles-ün ǰiruqai*). Then, an incomprehensible (for my ability), but certainly *'byung rtsis* (elemental calculation) follows. Mongolian folio numbers exist in the left margin and Chinese folio numbers in the right margin. I think that because the block print was carved in Beijing by Chinese carvers, who do not know Mongolian, the Chinese pagination is a better method for presenting the folio numbers.

[824] Mergen gegen (1998a: *huang shang yi ri* 82–*huang shang yi ri* 83). The *türgen ǰiruqai* is a rendering of *mgyogs rtsis*. The *γarun abulγa* is another Mongolian rendering of *lag len.* See above note 822.

[825] Mergen gegen (1998b: *huang shang yi ri* 84–*huang shang yi ri* 86).

ǰil/3/0]. The *mda' ro lhag ma* is given as 29 (M. *sübe nidü*) and *ril cha* is given as 24/33 ((M. *oron* (24), *γal üǰügür* (33)). It seems that the *gza' dhru* and *nyi dhru* values at 1747/3/0 were calculated incorrectly as $1^{z}38^{q}4'$ (M. *dürsü* (1), *loos γal* (38), *usu* (4)) and $26^{k}48^{q}11'$ (M. *ǰabsar nidün* (26), *loos usu* (48), *doγsin* (11)), respectively.[826] Let me single out the expressions of the conceptual and astronomical terms, according to the sequence of the general calculations.

Table 57.

Mergen gegen (1998b)	relevant *skar rtsis* terms
ariγun sar-a	*zla dag*
rilbu časai (*čašai*)	*ril bo cha shas*
γaraγ-un dho(*u*)*ru-a*	*gza' dhru*
naran-u dho(*u*)*ru-a*	*nyi dhru*
an explanation was not found	*gza' bar*
an explanation was not found	*nyi bar*
saran-u köl	*zla rkang*
the term was not found[827]	*gza' phyed dag pa*
naran-u köl	*nyi rkang*
saran odu	*zla skar*

My general assessment is as follows: Mergen Gegen's explanation of the sequence of the *byed rtsis* is incomplete, which may mean that his understanding on the Tibetan *skar rtsis* was meager and terse. Most of all, astronomical technical terms were not conceptualized in Mongolian and some Tibetan / Sanskrit terms were used without being translated into Mongolian. It can be assumed that because of his low-level understanding, he could not

[826] The correct values are as follows: the *gza' dhru* is $1^{z}38^{q}10'$ and the *nyi dhru* is $26^{k}48^{q}33'5''1'''$.

[827] The folio *huang xia yi ri* 85 shows the process of the calculation in the *gza' phyed dag pa*. However, no Mongolian equivalent of the Tibetan *gza' phyed dag pa* was found.

present thorough and appropriate renderings of all the *skar rtsis* technical terms. Of course, the coinage of Mongolian words attempted by Mergen Gegen was not common in later period of Mongolian Buddhism when Mongolian lamas used Tibetan texts.

Next, let us look into his understanding of eclipse calculations as seen in the *Naran gerel,* which is filled with undecodable and strange orthography and scripts *passim*. His explanations for the calculation of a lunar eclipse range from *huang xia yi ri* 76 (= 29b) to *huang xia yi ri* 77 (= 30b)[828]. The eclipse limit is as follows: *terigün* (T. (*sgra gcan*) *gdong*) — *saran* (T. *zla ba*) < 50. *saran* – *segül* (T. (*sgra gcan*) *mjug*) < 40. *busud-a* ("other cases") < 45.[829] Interestingly, he mentioned that the following factors need to be examined for a lunar eclipse: "length of evening, the moon's movement to the south and the north, wide and narrow and high and low of a place, etc.." (*söni-yin urtu aqur ba. saran-u emünegsi umaraγsi odqui ba. oron-u aγui čiqul öndür boγuni terigüten*).[830] In addition, the magnitude (M. *yeke baγ-a*) can be calculated in the same manner as *skar rtsis*: the *möče* (*chu tshod*) value of the node-difference is divided by 5. For example, "in the case of *terigün* — *saran*" (*saran-iyar terigün-i arilγabasu*), 0-4 : total eclipse (M. *büküli bariyu*), 5: $\frac{5}{6}$, 6: $\frac{2}{3}$, 7: $\frac{1}{2}$, 8: $\frac{1}{3}$, 9: $\frac{1}{6}$, 10: $\frac{1}{8}$ is

[828] For his explanation on the calculation method of *raquyin* (*sic*. read *raqu-yin*) *ündüsü* (T. *rtsa*), *terigün* (T. *gdong*), and *segül* (T. *mjug*), see Mergen gegen (1998: *huang shang yi ri* 61 (= 14a)–*huang xia yi ri* 61 (= 14b)) in the same text.

[829] The *busud-a* means either the following two cases: 1) *segül* — *sara*, 2) *sara* — *terigün.*

[830] Mergen gegen (1998: *huang xia yi ri* 76 (= 29b)). These factors are usually mentioned in the Tibetan *skar rtsis* calculation of a solar eclipse. See above pp. 287-90. In fact, geometric and geographical knowledge is necessary for the calculation of a solar eclipse.

obscured, respectively. Also, another interesting statement can be found: "due to the fact that time is [calculated by] *tshes zhag* (M. *sin-e-yin qonuγ*), all lunar eclipses occur on the sixteenth, solar eclipses occur on the first *tshes zhag*. because of that ... ." (*čaγ inu sineyin* (*sic.* read *sin-e-yin*) *qonuγ-un erkeber. saran bariqui bügüde arban ǰirγuγan-a, naran bariqui sine-yin nigen-e bolqui-yin tula* ...). This may be a deviation from the traditional understanding of *skar rtsis*.[831] If this is the case, the interpretation may have been influenced by the Qing Chinese lunar calendar. Solar eclipses occur on the first lunar day according to the Chinese lunar calendar. By "*sin-e-yin qonuγ*," he may have meant the Chinese lunar date, not the Tibetan *tshes zhag.* Another possibility is that he may have meant that lunar and solar eclipses occurred on those dates if calcualted by the values of the *gza' dag* in the *skar rtsis* calculations and ensuingly corrections to the calcuation results are made to reflect Inner Mongolian time. In this case, he meant *tshes zhag* in *skar rtsis* by the "*sin-e-yin qonuγ*" and it would be the case that his statement is based upon emprical data from Inner Mongolia. More research is needed.

His explanation of the calculation of a solar eclipse (M. *naran-i bariqui*) ranges from *huang xia yi ri* 77 (= 30b) to *huang shang yi ri* 79 (= 32a). The eclipse limit is given as: *terigün* – *naran* (T. *nyi ma*) < 5. *naran* – *segül* < 8. *busud-a* ("other cases")[832]< 40. The magnititude, timing (M. *čaγ*), color (M. *üngge*), and direction (M. *ǰüg*) are followed as expected in the

[831] In the case of *skar rtsis*, the timing of a lunar and solar eclipse is fixed as that of the termination of the 15th and 30th *tshes zhag,* respectively. Additionally, corrections to the time may be applied.

[832] This means either the following two cases: 1) *nara* – *terigün*, 2) *segül* – *nara.*

skar rtsis eclipse calculations. He says that he learned the calculation methods from Bančin Šakiy-a šrii (possibly < Paṇ chen Śākyaśrī).[833] Generally, his descriptions are merely reiteration of the algorithm for the calculations of lunar and solar eclipses. Basically, no difference or further development from the Tibetan *skar rtsis* methods in terms of mathematics and technical considerations is observed.

On the basis of my readings of the *Angqan-u degedü burqan-ača γarγaγsan čoγ-tu čaγ-un kürdün neretü dandris-un qaγan, Gkir ügei gerel-tü* and Mergen Gegen's texts, I suggest that Mergen Gegen did not use or read the Mongolian *Kālacakra* corpus. No relationship between *Čaγ-un kürdün* and *odun-u ǰiruqai* can be found in terms of astronomical technical terms and concepts.

As a matter of fact, it is not likely that the *Γanǰuur* / *Danǰuur* was accessible or studied seriously by the Mongolian lamas. More research is needed, but the terminological and conceptual uniformity seen in the Mongolian *Kālacakra* corpus, which dates back to the *Altan Γanǰuur* at the latest, may have been fossilized without being used by Mongolian lamas. In terms of the relationship between the *Kālacakra* and *skar rtsis*, Tibetans made great efforts to translate and understand the abstract *Kālacakra* texts, and *skar rtsis* has been established in Tibet for centuries through incorporating many factors from observations, empirical data, debates, criticism, research into neighboring traditions, etc., while balancing itself with the *Kālacakra*. However, it may be assumed that

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[833] See Mergen gegen (1998: *huang shang yi ri* 79 (= 32a)). This transliteration is interim. The script is difficult to read. It seems that *bančin* (< T. *paṇ chen*) means great *paṇḍita,* not the *Dge lugs* title *paṇ chen bla ma.*

the Mongolians may have just imported the accumulated knowledge of *skar rtsis* from Tibet.

In the above debate, I pointed out that the establishment of astronomical terminology, the intended or unintended mistranslations in the *Gkir ügei gerel-tü*, and the independent development of the *odun-u ǰiruqai* as separate from the *Čaγ-un kürdün* are observed in Mongolian *Čaγ-un kürdün* texts. More evidence may be located in the future to strengthen or repudiate these claims, but one possible counterargument is that the Mongolian texts investigated in this work may not represent astronomical research in Mongolian monasteries, simply because Mongolians used Tibetan texts and canons rather than Mongolian ones. In fact, Mergen Gegen is an exception in terms of the creation of texts in Mongolian. In other words, it may be said that Mongolians had no knowledge of the Mongolian *Čaγ-un kürdün* and studied the Tibetan *skar rtsis* / *Kālacakra* and that Mergen Gegen's attempts to use Mongolian were merely restricted to his particular monastery, Mergen süm-e is not entirely in Mongolia. My response would be thus: the aforementioned Mongolian materials are important in that they accurately show how Mongolians understood Indo-Tibetan terms, concepts, ideas, and theories. It may be the case that the *Čaγ-un kürdün* translations were not used or Mergen gegen's writings just reflect a local tradition, but Mongolians spoke Mongolian, even if they used Tibetan texts. Their understanding can be better grasped by their writings that are written in their mother tongue, Mongolian, and the terms, concepts, ideas, etc. that were described in the Mongolian texts may be common to Mongolian lamas with limited or less common religious experiences. In that sense, the Mongolian texts I used in the above are the best evidence for showing Mongolian understanding.

All in all, based upon my observations, it may be assumed that the knowledge of the Mongolian lamas, who are the *Rgya rtsis chen mo* translators, functioned under or were as least related to the aforementioned circumstances. Of course, at present, we do not know how good their understanding on the *Čaγ-un kürdün* and *odun-u ǰiruqai* was.

Next, how did the Mongolian lamas in Beijing and Ulaγanbaγatur, who were equipped with knowledge of the *Čaγ-un kürdün* / *odun-u ǰiruqai*, translate the *Tngri-yin udq-a*, which is based upon modern astronomy? With a focus on the relationship between the *Čaγ-un kürdün* and the *Tngri-yin udq-a* in terms of terms and concepts, I will attempt to answer this question. The basis of my answer is as follows: knowledge of the *Kālacakra* could have been used for the parallel concepts and terms in the *Tngri-yin udq-a* if the translators understood the *Tngri-yin udq-a*.

Let us briefly discuss this point by using the following passage in the Ch. *Yuelibiao yongfa* (月離表用法) / M. *saran-u tuγulqu-yin bodurul-un kereglekü ǰirulγ-a* / T. *zla ba brgal ba'i ngos 'dzin gyi dgos pa'i ri mo*:

> 諸表皆用以求月離宮度分也 凡步月離有二法 皆先求月平行度分 次一法用三角形法推求均度以加以減 又一法用加減立成表查均數 [834]以加以減 但正朔望時止用一均數一加減表 餘日皆用二均數 [835]二加減表.[836]

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[834] To understand *junshu* (均數. inequality), lunar inequalities (= irregularities), which change the Moon's position, thus the calculations for these are necessary for eclipse calculation, and should be understood. They were discovered over a long period of time in Western astronomy. Roughly, let us begin with the Ptolemaic lunar model. In it, the first inequality *C* (defined as equation of the center), which was already known in Hipparchus's time, was applied. It reflects that moon's slow motion from apogee to perigee and

fast motion from perigee to apogee and the influence of the longitude of the moon. For more information, see Jacobsen (1999: 53). The second inequality, evection, was discovered by Ptolemy himself. It depends on the distance of the moon from the sun and moon's mean anomaly. See Pedersen (1974: 182-4). After significant time had passed, Tycho Brahe refined the Ptolemaic lunar theory by means of observations. He added three substantial discoveries: the third inequality, 'variation,' reflects that the moon moves faster than expected at new and full moon, and slower at the quarters. See Dreyer (1890: 337-8) and Thoren (1967: 161-4). The fourth inequality, annual inequality, is an annual effect, by which the lunar motion slows down a little in January and speeds up a little in July. The fifth inequality is the inclination of the lunar orbital plane with regard to the ecliptic. It influences lunar latitude at syzygy and quadrature. For more information on the inequalities, see Watanabe (1959: 303-5), Thoren (1989: 16-9), Thoren and Christianson (1990: 324-33, 486-96), Jacobsen (1999: 157-63), Swerdlow (2004: 3-7), and *The Facts on File Dictionary of Astronomy* (2006: 157, 505), etc.. In fact, we are aware that the moon's inequalities are much more complex than those disclosed by Brahe, but Brahe's discoveries fit nicely with the *Xiyang xinfa lishu,* based upon Brahe's lunar model. Of course, the differences between the earlier and later Brahe lunar models should be considered. See below in this note. In the *Xiyang xinfa lishu*, the inequalities are called *junshu*: *C* (Ch. *yijunshu* 一均數), evection (Ch. *erjunshu* 二均數), and 'variation' (Ch. *sanjunshu* 三均數). Let me first introduce the previous research into these concepts. During the investigation into the *Yuelibiao* (月離表. The Lunar Table) in the *Chongzhen lishu*, Hashimoto (1988: 111) pointed out that lunar theory in the *Chongzhen lishu* is Brahe's: "As for Tycho's discoveries of the third and fourth inequalities, the Chinese text reflects nothing, but giving the modified tables in the four books of the Lunar Tables (Ch. *Yuelibiao*) from Longomontanus's *Tabula Prosthaphaeresium Lunarium* and *Tabula Secunda Prosthaphaeresium Lunarium* in the *Astronomia Danica*." The lunar theory in the *Xiyang xinfa lishu* developed in a more elaborate way than that in the *Chongzhen lishu*, but because the Tychonic model in the *Chongzhen lishu* is basically the same with that in the *Xiyang xinfa lishu*, the *Chongzhen lishu* can be used to explain the *Xiyang xinfa lishu*. Regarding this, Chu and Shi (2013: 335-40) presented detailed research into the lunar model in the *Yuelibiao*: *benlun* (本輪) that was devised for *C*, *cilun* (次輪. equivalent to the first epicycle) for evection, and *youcilun* (又次輪 and is equivalent to the second epicycle) for 'variation' (Ch. *erjuncha* 二均差 = *sanjunshu*). For Brahe's double epicycle model for the moon seen in the *Chongzhen lishu / Xiyang xinfa lishu*, see Rho et al. (2009: 701), Hashimoto (1988: 107-11), and Ning (2007: 25-37). In addition, Chu and Shi (2013: 331-5) suggests that the lunar theory in the *Chongzhen lishu* is based upon the later Tychonic model (published in the *Astronomiae Instauratae Progymnasmata* (1602)) on the basis of Swerdlow (2009: 11-31): The earlier Tychonic lunar model (1599) includes 'variation' and an annual equation. However, in the later Tychonic model, added and subtracted by his assistant Longomontanus (1562-1647), *C* was corrected and the annual equation was deleted.

[835] In the case of the *Xiyang xinfa lishu*, the maximum value of the *yijunshu* is 4°58'; see Rho et al. (2000: vol. 4, 217) [= Rho et al. (1983: 577)]. The value of the *Lixiang kaocheng* from which the *Mā yang rgya rtsis* originates is similar; the maximum value of the *chujunshu* (初均數) (= *yijunshu*) is 4°58' . The values of " and below are different; see He et al. (1985: 203), (1985a: 67), and Zhang1 (2014: 100). The *erjunshu* and *sanjunshu* are given in the summation of these (defined as *ersan junshu* 二三均數). The maximum value of the *ersanjunshu* is 2°48'; Rho et al. (2000: vol. 4, 263) [= Rho et al. (1983: 622)]. In the case of the *Lixiang kaocheng*, 2°48' is given; see He et al. (1985a: 237). It can be speculated that the values are closely tied to those of Tycho Brahe.

[836] See Rho et al. (2000: vol. 4, 200) [= Rho et al. (1983: 560)].

aliba bodurul, čüm saran-u tuɣulqu-yin ordu qonuɣ qubi-yi erikü i-dür kereglemüi. aliču saran-u tuɣulqui-yi boduqui-dur, qoyar ǰirulɣ-a bui, čüm urida saran-u tübsin yabudal-un qonuɣ qubi-yi erimüi. daraɣ-a nigen ǰirulɣ-a anu, ɣurban ünčüg-tü düri-yin ǰirulɣ-a-bar tegsilel-ün qonuɣ-i erin boduǰu nememüi baɣuraɣulumui. Basa nigen ǰirulɣ-a anu, nemekü baɣuraɣulqu baiɣul-un bütügegsen bodurul-ača tegsilel-ün toɣ-a-yi baičaɣaǰu nememüi baɣuraɣulumui. ɣaɣča-qu tüb sin-e, tergel čaɣ-tur, nigedüger tegsilel-ün toɣ-a, nigedüger nemekü baɣuraɣulqu bodurul-i kereglemüi. busu edür bügesü, čüm qoyaduɣar tegsilel-ün toɣ-a, qoyaduɣar nemekü baɣuraɣulqu bodurul-i kereglemüi.[837]

ngos 'dzin gang yang kun zla ba brgal ba'i khyim zhag cha shas btsal ba la dgos so / zla ba gang yang brgal ba'i dpyad pa la ri mo gnyis yod / kun zla ba snga ma'i snyoms 'gros[838] *kyi zhag dang cha shas btsal ba'o / de rjes su ri mo gcig ni / zur gsum gyi rnam pa'i ri mos bsnyams pa'i zhag btsal zhing dpyad de bsnon nam phri ba'o / yang ri mo gcig ni bsnon phri / bkod cing bsgrub pa'i ngos 'dzin las bsnyams grang (sic.* read *grangs) chas*[839] *te bsnon nam phri ba'o / gcig pu dkyil tshes dang nya*[840] *dus la bsnyams grang (sic.* read *grangs) dang po / bsnon phri'i ngos 'dzin dang po dgos so / nyin gzhan yin na kun bsnyams grangs gnyis pa / bsnon phri'i ngos 'dzin gnyis pa dgos so / .*[841]

The translation of the Tibetan paragraph with the help of the Chinese and Mongolian passages is as follows:

> "All the tables are necessary for the *khyim*, *zhag*, and *chas shas* at the moon's position (T. *zla ba brgal ba*). There are two methods for examining the position of the moon. Both of them firstly calculate the degrees (T. *zhag*) and parts (T. *cha shas*) of the mean motion of the moon. After that, the first method is to calculate the mean degree (T. *bsnyams pa'i zhag*.

[837] *Tngri-yin udq-a* (1711: *saran-u tuɣulqu-yin bodurul nigedüger*, 1-2) [= Čeden et al. (1990: 86)].

[838] There is a mistranslation in Tibetan. *Xian* (先)/ *urida*, which are "firstly," are separate from *yue* (月)/ *saran,* which are "the moon." See the English translation. The Tibetan rendering of "the preceding month" (*zla ba snga ma*) is wrong.

[839] *chas* was given for the rendering of *baičaɣaǰu* (< Ch. *cha* (查). "look for," "look up."). This is problematic.

[840] *dkyil tshes* / *dkyil nya* were given for *zhengshuowang* (Ch. 正朔望. "true conjunctions."). Meanwhile, *dag tshes* / *dag nya* are given in the *Mā yang rgya rtsis* texts. The different terms may be evidence that the *Mā yang rgya rtsis* is not a continuation of the *Rgya rtsis chen mo*.

[841] *Rgya rtsis chen mo* (1715/1716: (left margin) *ga* 1b [= (right margin) *juan* (卷) 3, *shang* (上) 1]). The *shang* 1 is not a match to 1b. It should *xia* (下) 1.

> < M. *tegsilel-ün qonuγ* < Ch. *jundu* 均度) by the method of triangle (T. *zur gsum gyi rnam pa'i ri mo.* trigonometry) and then to add [the calculated value] to or subtract [it] from [the mean motion]. Also, the second method is to look up the *junshu* (T. *bsnyams grangs*) in the table of addition/ subtraction (T. *bsnon phri bkod cing bsgrub pa'i ngos 'dzin* < M. *nemekü bayurayulqu baiyul-un bütügegsen bodurul* < Ch. *jiajian lichengbiao* 加減立成表) and then to add [the value] to or subtract [it] from [the mean motion]. The equation of the center (T. *bsnyams grangs dang po* < M. *nigedüger tegsilel-ün toγ-a* < Ch. *yijunshu* 一均數) and the first table of addition/ subtraction (T. *bsnon phri'i ngos 'dzin dang po* < M. *nigedüger nemekü bayurayulqu bodurul* < Ch. *yi jiajianbiao* 一加減表) are necessary only at true conjunctions. Evection (T. *bsnyams grangs gnyis pa* < M. *qoyaduγar tegsilel-ün toγ-a* < Ch. *erjunshu* 二均數) and the second table of addition/ subtraction (T. *bsnon phri'i ngos 'dzin gnyis pa* < M. *qoyaduγar nemekü bayurayulqu bodurul* < Ch. *er jiajianbiao* 二加減表) are necessary for the other days."

The above passage explains two methods for computing lunar anomalies.[842] There are some interesting features in the above Tibetan passage. Firstly, the Tibetan paragraph is a literal translation of the Mongolian paragraph, with some misunderstandings. I do not think that when the translators rendered *nigedüger tegsilel-ün toγ-a* as *bsnyams grangs dang po,* they knew the meaning or the astronomical background of Tychonic astronomy. Also, the Tibetan translation with new coinage of modern astronomical terms could be understood only if a Tibetan reader with knowledge of modern astronomy reads it in combination with the original Chinese and Mongolian texts. Secondly, the use of *skar rtsis* terms are limited to the spatial units, such as *khyim* (M. *ordu*, Ch. *gong* 宫), *zhag* (M. *qonuγ*, Ch. *du* 度), and *cha shas* (M. *qubi*, Ch. *fen* 分). Thirdly, the translators did not use the *skar rtsis* terms, even for parallel concepts. For example, *nyi rkang* was not used for *naran-u kerükü* (*richan (*日躔*), nyi ma'i myur ba* was given in the translation), *zla rkang* was not used

[842] For Tychonic methods for calculating true moon from mean moon by reflecting inequalities, see Jacobsen (1999: 163-9) and Chu and Shi (2013: 336-40). For modern method of calculating the position of the moon, see Meeus (1988: 147-53), (1998: 337-44). For a simple explanation, see Duffett-Smith and Zwart (2011: 164-6).

for *saran-u tuɣulqu* (*yueli* (月離), *zla ba brgal ba* was given), and *gza' 'dzin* was not used for *solbičan bariqu* (*jiaoshi* (交食), *bsnol bar 'dzin pa* was given). Of course, the Tibetan renderings of the *Rgya rtsis chen mo* may have worked in most cases because they did not create a large difference in meaning. Except for the case of the rendering of *baiɣul-un bütügegsen bodurul* (*lichengbiao* (立成表), which means table.), the Tibetan *verbatim* rendering from the Mongolian term, *bkod cing bsgrubs pa'i ngos 'dzin*, is not understood. They could simply have used the *skar rtsis* term *re'u mig* (or *ngos 'dzin* as is used in the *Rgya rtsis chen mo*).[843] I suggest, from these instances, that the translators did not discover a link to the *Kālacakra* in terms of terminology and concepts, which is caused by their ignorance of modern astronomy. Alternatively, they may have thought that the descriptions in the *Tngri-yin udq-a* were irrelevant to the *Kālacakra*. Therefore, they may have consistently tried the *verbatim ac litteratim* translation, even in the parts where the *Kālacakra* terms and concepts could have worked. In any case, I think that if they had knowledge of both the *Kālacakra* / *skar rtsis* and modern astronomy, the influence of the former on the latter and *vice versa,* in terms of the use of terms and concepts, would have appeared in the Tibetan translation *Rgya rtsis chen mo*.

Another example in the following enables me to verify that the corollary of the *verbatim ac litteratim* translation, without knowledge of relevant field, is a translation filled with errors and incomprehensible terms. For example, see Ch. *Jiaoshibiao juan* 8

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[843] However, it should be noted that *ngos 'dzin* has never been used as "tables" in the Tibetan *rtsis* texts, except for this translation, which is problematic.

(交食表　卷 八) / M. *Solbičan bariqu-yin bodurul Naimaduγar* / T. *Bsnol bar 'dzin pa'i ngos 'dzin / legs bam brgyad pa.*

> 視差者乃太陽太陰高下視差 皆以距天頂度及距地心地半徑數所求得者 蓋太陽距地遠近以最高最庳為限 兩限中遠近之數依中比例法可算.[844]
>
> *qaraqu dutaγu kemegči inü, mün naran, saran-u öndür boγuni-yin qaraqu dutaγu. čüm tngri-yin orui-ača böglegüü-yin qonuγ, ǰiči γaǰar-un küisün-eče böglegüü, γaǰar-un qaγas tursi toγ-a-bar eriǰü, oluγsan bolai. yerü naran, γaǰar-ača böglegüü-yin qola oir-a-yi, yerü öndür, yerü boγuni-bar quγuča bolγamui, qoyar quγuča-yin qoγurundu-yin qola oir-a-yin toγ-a-yi dumdadu ülikü üliger-ün ǰirulγ-a-yin yosuγar boduǰu bolumui.*[845]
>
> *blta ba'i dman pa zhes pa ni / nyi zla nyid kyi mtho dman gyi blta ba'i dman pa kun gnam gyi gtsug nas rgyang ba'i zhag / slar sa'i lte ba nas rgyang ba / sa'i phyed srid grangs kyis btsal nas thob bo / spyir nyi ma sa nas rgyang ba'i nye ring spyir mthon po spyir dma' bas thun du bya ba'o / thun gnyis kyi bar gyi nye ring gi grangs / gzhal dpe dbus ma'i ri mo'i lugs bzhin dpyad par 'gyur ro /.* [846]

The translation of the Tibetan passage with the help of the Chinese and Mongolian passages is as follows:

> Parallax (T. *blta ba'i dman pa*) is the *gaoxia shicha* (= *gaoxiacha* in the *Lixiang kaocheng*) of the sun and moon (T. *nyi zla nyid kyi mtho dman gyi blta ba'i dman pa* < M. *naran, saran-u öndür boγuni-yin qaraqu dutaγu* < Ch. *taiyang taiyin gaoxia shicha* 太陽太陰高下視差).[847] Both are obtained by degrees from the zenith (T. *gnam gyi gtsug nas rgyang ba'i zhag* < M. *tngri-yin orui-ača böglegüü-yin qonuγ* < Ch. *ju tianding du* 距天頂度) and the values of the semi-diameter of the earth distant from the center of the earth (T. *sa'i lte ba nas rgyang ba / sa'i phyed srid grangs* < M. *γaǰar-un küisün-eče böglegüü, γaǰar-un qaγas tursi toγ-a* < Ch. *ju dixin dibanjingshu* 距地心地半徑數). Generally, [in the case of] the sun's distance to the earth (T. *nyi ma sa nas rgyang ba'i nye ring* < M. *naran, γaǰar-ača böglegüü-yin qola oir-a* < Ch. *taiyang ju di yuanjin* 太陽距地遠近), the highest (T. *spyir mthon po* < M. *yerü öndür* < Ch. *zuigao* 最

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[844] Rho et al. (2000: vol. 2, 202) [= Rho et al. (1983: 457)].

[845] *Tngri-yin udq-a* (1990: 663).

[846] *Rgya rtsis chen mo* (1715/1716: *na*, 1b [= *juan* (= vol.) 20, *xia* 1]).

[847] See above notes 325 and 668.

> 高) and the lowest (T. *spyir dma' ba* < M. *yerü boγuni* < Ch. *zuibei* 最庳) are taken as the limits (T. *thun* < M. *quγuča* < Ch. *xian* 限). The values of the distance between the two limits (T. *thun gnyis* < M. *qoyar quγuča* < Ch. *liangxian* 兩限) can be calculated by the calculation method of middle proportion (T. *gzhal dpe dbus ma'i ri mo* < M. *dumdadu ülikü üliger-ün ǰirulγ-a* < Ch. *zhongbilifa* 中比例法).[848]

The above passage explains how to calculate the diurnal parallax[849], one of the most important factors incorporated in the the calculation of a solar eclipse. Again, Tibetan paragraph alone cannot be understood. It also shows that the translators had no knowledge of modern science and mathematics, including trigonometry. The indecipherable term *gzhal dpe* for Chinese *bilifa* (比例法) and Mongolian *ülikü üliger-ün ǰirulγ-a* is given. A Tibetan reader will not be able to find how to understand this term just with the Tibetan translation. Given the Chinese and Mongolian paragraphs, calculations can be proposed to involve proportional expressions and the relevant interpolation / extrapolation. I do not think that Tibetan readers will be able to come up with these concept with only the Tibetan text. All in all, I think that the translators' knowledge of *Kālacakra* was impotent when being confronted with modern science.

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848 The *zhong bilifa* (中比例法 > M. *dumdadu ülikü üliger-ün ǰirulγ-a* > T. *gzhal dpe dbus ma'i ri mo.* lit. a calculation method by middle proportion) is certain to be a calculation method involving proportional expressions, but I do not know the exact way the values of parallax are calculated here. According to the explanation of the calculation from the *dibanjingcha* (地半徑差. diurnal parallax) in the *Lixiang kaocheng*, the "three limits" (apogee, perigee, and middle) are in accordance with the proportion between the calculated semi-diameter of the earth and the sun's distance to the center of the earth (地半徑與太陽距地心比例, 高、卑、中距三限) and the same these are applied in the calculation of the *dibanjingcha* of the moon; see *Qingshigao*, *juan* (卷) 47, *zhi* (志) 22, *shixian* (時憲) 3. The above *zhong bilifa* may be related to a calculation of the proportion for middle distance ("*zhongju*" 中距 in the *Lixiang kaocheng* / *Qingshigao*) from the "two limits" (*liangxian* 兩限) in the above passage. More research is needed.

849 For a understanding of this term, see Seidelmann and Urban (2012: 123-5).

In the early 18th century, there was a clear demarcation between two different astronomies among Mongolian intellectuals: secular Mongolian modern astronomers were active in the Qing court and Mongolian lamas studied the monastic astronomy, specifically *Čaγ-un kürdün* and *odun-u ǰiruqai*, in Buddhist monasteries. The former produced the *Tngri-yin udq-a* on the basis of the firm understanding of contemporary Qing Chinese (essentially Western) astronomy; the latter studied the *Kālacakra* and *skar rtsis* / *odun-u ǰiruqai*, for the most part in Tibetan. The clear demarcation between modern science and the monastic astronomy may not have been a favorable situation for the translation of the *Tngri-yin udq-a* into Tibetan. I speculate that no Mongolian scientists in the Qing court knew Tibetan, and no Mongolian and Tibetan (including the Qing court Mongolian and Tibetan) lamas knew modern astronomy.[850] In such situation, it may be that the *Tngri-yin udq-a* had no choice but to be given to the lamas at Ulaγanbaγatur for translation into Tibetan, Or, Elhe taifin Kangxi Emperor's political concerns may have worked. We do not know how and why these concepts travelled far away from the court.[851] At any rate, the outcome was clear from the inception: the lamas, who are assumed to have had knowledge of the *Čaγ-un kürdün*, were not able to translate the text

[850] Some lamas in Beijing may have had a certain level of knowledge regarding modern astronomy, but because no lamas appear in Ruan (1842) and Pfister (1932-1934), it can be supposed that, if any, they were not specialists. We can leave the issue open for future research.

[851] It is frustrating to trace information on how the *Tngri-yin udq-a* was given to the Rje btsun Dam pa I for translation. Dza ya (Jaya) Paṇḍita Blo bzang 'phrin las (1981), a biography of the Rje btsun Dam pa I, is not helpful in that respect. There may exist some relevant information somewhere in Mongolian, Manchurian, Chinese, or Tibetan texts, but currently, the printer's colophon of the *Rgya rtsis chen mo* is the only source which explains the process involved in the translation.

properly due to a lack of knowledge regarding modern astronomy. Also, knowledge of the *Čaγ-un kürdün* did not function in the translation. As a result, both the *Čaγ-un kürdün* and modern astronomy are absent in the Tibetan translation *Rgya rtsis chen mo*. Nevertheless, the *Rgya rtsis chen mo* came into being merely because of the following reason: the Mongolian in the *Tngri-yin udq-a,* which is very close to present-day colloquial Mongolian, made possible the creation of the Tibetan calques and renderings in the *Rgya rtsis chen mo*, but with many mistakes, indecipherable pidgin, and calques.

Lastly, I should restress the following fact in conjunction with one of my concerns in chapter 3, i.e. the significance of the *Rgya rtsis chen mo* in the history of Tibetan astronomy: it could not be used because of its strange terms, concepts and theories. There is also no evidence that it was circulated. Even if it were circulated in Tibet, it would have had no impact in the 18th century (and even today). I am quite curious about who would have been able to understand it properly! In the same vein, the argument that the *Mā yang rgya rtsis* was created on the basis of an understanding of the *Rgya rtsis chen mo* is nonsensical. The origin of the *Mā yang rgya rtsis* was clarified in chapter 3 .

ABBREVIATIONS

anno.	annotated
AO	*Acta Orientalia*. Leiden: Lugduni Batavorum apud Brill, 1923~ .
BJAMS	*Bulletin of the Japan Association for Mongolian Studies / Nihon mongoru gakkai kiyō* 日本モンゴル学会紀要
CAJ	*Central Asiatic Journal*
Ch.	Chinese
C.P.N.	Cultural Palace of Nationalities [= Minzu wenhua gong 民族文化宫]
D.	*Sde dge* edition Tibetan *Bka' 'gyur* and *Bstan 'gyur*.
ed.	edited
EFEO	*L'École Française d'Extrême-Orient.*
G.	Greek
HJAS	*Harvard Journal of Asiatic Studies.*
IIJ	*Indo-Iranian Journal.*
JA	*Journal Asiatique.*
JAOS	*Journal of the American Oriental Society*.
JHA	*Journal for the History of Astronomy*.

JIABS	*Journal of the International Association of Buddhist Studies*.
JIATS	*Journal of the International Association of Tibetan Studies*.
JIBS	*Journal of Indian and Buddhist Studies / Indogaku bukkyōgaku kenkyū* 印度學佛教學研究
JIP	*Journal of Indian Philosophy*
L.	Latin
lit.	literally
Man.	Manchu
M.	Mongolian.
Ōtani.	*Ōtani daigaku toshokan zō eiin Pekin-ban chibetto daizōkyō sōmokuroku, sakuin*. Ed. Chibetto Daizōkyō Kenkyūkai. Kyōto: Rinsen Shoten 1985 [Original print: Tōkyō: Suzuki gakujutsu zaidan, 1962]. The Catalogue of *P*.
P.	Peking Edition Tibetan *Bka' 'gyur* and *Bstan 'gyur.*
P.	Pāli
r.	reign
RET	*Revue d'Etudes Tibétaines.*
rev.	revised
SKQS	*Yingyin wenyuange sikuquanshu* (景印 文淵閣 四庫全書)
S.	Sanskrit

TBRC	Tibetan Buddhist Resource Center
TG	*Tōhō gakuhō* 東方學報
T.	Tibetan
Tōh.	*A Complete Catalogue of the Tibetan Buddhist Canons* (*Bka' 'gyur* and *Bstan 'gyur*). Sendai: Tōhoku University, 1934.
TP	*T'oung pao* 通報
tr.	translated
UAJ	*Ural-Altaische Jahrbücher*
XY	*Xizang yanjiu* 西藏研究
ZDMG	*Zeitschrift der deutschen morgenländischen Gesellschaft*
ZKY	*Ziran kexueshi yanjiu* 自然科学史研究
ZKS	*Zhongguo keji shiliao* 中国科技史料
ZKZ	*Zhongguo kejishi zazhi* 中国科技史杂志
ZS	*Zentralasiatische Studien des Seminars für Sprach- und Kulturwissenschaft Zentralasiens der Universität Bonn.*

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Yum pa. Bod kyi gnam rig skar rtsis rig pa'i brtsi byed ma lag.